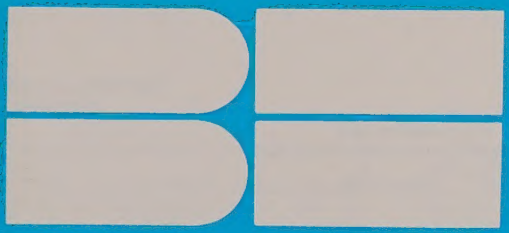

BERRY ELECTRONICS

966A
TRUNK SIGNALING ANALYZER
OPERATING MANUAL

Berry Electronics Incorporated, 719 Swift Street, Santa Cruz, California 95060

MODEL 966
TRUNK SIGNALING ANALYZER

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1. GENERAL

A. Scope of the Manual

1.01 This manual describes the features, operation and maintenance of the 966A and 966R Trunk Signaling Analyzer models. Application information and detailed testing procedures are also included. A brief description of Multifrequency (MF), TOUCH-TONE /Dual Tone Multifrequency (DTMF) and Dial Pulse (DP) signaling systems are furnished as an aid to understanding and using the 966A and 966R Trunk Signaling Analyzer models.

1.02 This manual has been re-issued to incorporate equal access features and to add the DROP & INSERT and the rack mount operation and specifications.

1.03 Terms, abbreviations and acronyms used in this publication are listed in Table A.

B. Applications

1.04 The Model 966A Trunk Signaling Analyzer is a portable Multifrequency (MF), TOUCH-TONE /Dual Tone Multifrequency (DTMF) (Option 03) and Dial Pulse (DP) receiver. It is able to detect, store, display and analyze address, pulse width and amplitude, and supervisory signaling digits and codes present on both two-wire and four-wire trunks.

1.05 The Model 966A Trunk Signaling Analyzer applications include:

- High impedance monitoring of both voice and signaling on analog and digital trunks (Option 04, 05) using loop or E&M supervision.
- Simulation of WINK start, DELAY DIAL start and BYLINK (Immediate Dial) types of Terminating Offices.
- Trapping intermittent signaling problems such as short duration or low level MF and DTMF signaling tones, mutilated MF digits and missing KP and ST codes.
- Determining the exact nature of MF pulsing failures.

1.06 The Model 966A Trunk Signaling Analyzer provides the operator with the capability to perform test functions not possible with conventional test equipment and methods. The instrument receives, stores, displays and analyzes, on a per digit basis, Multifrequency (MF), Dual Tone Multifrequency (DTMF Option 03) and Dial Pulse (DP) pulses from trunks employing LOOP or E&M supervision.

1.07 Originating and Terminating office supervision is continuously displayed before, during and after outpulsing has occurred. Individual MF and DTMF (Option 03) pulses are measured for length and amplitude and may be indi-vidually checked against operator-set limits. Mutilated MF pulses consisting of less than one tone or more two tones are recorded as errors and may be individually examined for tone content.

1.08 Testing with the 966A generally falls into two categories. These are MONITOR and SIMULATE. When used in the MONITOR function, the 966A receives and displays MF, DTMF (Option 03) and DP signaling while simultaneously displaying the Originating and Terminating office supervision. High impedance bridging is used to ensure no interference to the trunk being monitored.

1.09 In SIMULATE functions, the test set acts as the Terminating office and provides battery and supervision just as the real Terminating office would. All types of Terminating offices may be simulated inluding WINK start, DELAY DIAL start and BYLINK (immediate dial). The ability of the 966A to take the place of the Terminating office during testing simplifies many maintenance tasks. SIMULATE functions can be used to completely check trunks and trunk equipment prior to cutover even if the real Terminating office or facilities are not ready. Trouble on working trunks can be isolated by using SIMULATE functions to determine if the problem is in the Originating office, Terminating office or the facilities. SIMULATE functions can save significant time and money by allowing one person to test trunks without assistance from the Terminating office.

1.10 The Model 966A Trunk Signaling Analyzer may be used to test:

- Interoffice and intraoffice trunks

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TABLE A
TERMS, ABBREVIATIONS AND ACRONYMS

ABC	Auto Bill Call (Credit Card Call)
AIS	Automatic Intercept System
ANI	Automatic Number Identification
BPV	Bipolar Violation
CAMA	Centralized Automatic Message Accounting
CCC	Credit Card Call (Auto Bill Call)
CCIS	Common Channel Interoffice Signaling
CCITT	Consultative Committee on International Telegraph & Telephone
CO	Central Office
CXR	Loss of Carrier
DDD	Direct Distance Dialing
DF	Distribution Frame
DP	Dial Pulse
DS-1	Digital Signal Level 1 (1.544 MBPS)
DSX-1	Digital Signal Cross-Connect for DS-1
DTMF	Dual Tone Multifrequency (TOUCH-TONE*)
EA	Equal Access
ERL	Echo Return Loss
EXT	External
FRM	Loss of Frame
IDDD	International Direct Distance Dialing
IN	Input
IPM	Impulses Per Minute
ISC	International Switching Center
LED	Light Emitting Diode
MBPS	Mega-Bits Per Second (Million)
MDF	Main Distribution Frame
MF	Multifrequency
NMS	Noise Measuring Set
OUT	Output
PABX	Private Automatic Branch Exchange
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
POI	Point of Interface
PPS	Pulses Per Second
RMT	Remote Terminal Alarm
SB	Loss of Signaling Frame
TLP	Transmission Level Point
TMS	Transmission Measuring Set
TN	Test Number
TRS	Tip (T) Ring (R) Sleeve (S)
TSP	Traffic Service Position
TSPS	Traffic Service Position System
VF	Voice Frequency

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- Incoming and outgoing trunk equipment
- CAMA and ANI trunks
- TSPS and AIS trunks
- Incoming and outgoing PBX trunks
- IDD trunks

1.11 The Model 966A Trunk Signaling Analyzer provides the following features:

- Access up to 96 digits of MF, DTMF (Option 03) or DP analog trunk
- Audio monitoring via loudspeaker
- Detects no answer supervision
- Automatically detects short duration or low level MF and DTMF tones, no KP required, mutilated MF digits and missing KP or ST codes
- Displays Originating and Terminating office supervision
- Measures MF and DTMF (Option 03) tone pulse duration and level on a per digit basis
- Dual record display for TSPS, ANI, and IDDD calls
- Three record display for CCC calls
- Feature Group D Equal Access Simulations

C. Options

1.12 The applications of the Model 966A Trunk Signaling Analyzer depend on the options with which it is equipped. There are three options currently available for the Model 966A Trunk Signaling Analyzer. These three options and the features are:

1. Option 03, TOUCH-TONE* (DTMF): This internal option enables the test set to display and analyze TOUCH-TONE* (DTMF) Pulsing. MF and DP receive capabilities are included as standard features. In normal operating mode, Touch-Tone* is disabled and must be activated.

   To activate Touch-Tone*, press the "F" key for special feature selection. This puts the set in feature select mode, as indicated by a flashing "F" LED annunciator. Then press the "4" key. A flashing LED annunciator indicates feature selection. (If the LED is not lit, your unit is not equipped for DTMF operation.) Return the set to normal operating mode by pressing the "F" key again. The 966A is now ready to receive TOUCH-TONE*.

   To disable TOUCH-TONE*, enter the feature select mode again and press the "4" key and then return the set to normal operating mode. A steady LED annunciator indicates that the feature is disabled.

2. Option 04 DS-1 PCM RECEIVER: This option is built into the cover of the 966A test set. It provides the following features:

   - Allows the Model 966A Trunk Signaling Analyzer to monitor PCM carrier operating at the DS-1 (1.544 MBPS) rate.
   - Interfaces with systems employing D1D, D2, D3 and D4 coding.
   - Channel selection (1 of 24). A front panel thumbwheel switch allows easy selection channels.
   - Terminating (100 ohms) or bridging (1000 ohms) input impedance.
   - PCM error indicator (IE), bipolar errors, Frame Loss, Frame Error, and Remote Terminal Alarm.
   - Displays A and B bit status.
   - Selects the type of Supervision Decoding (CCIS or Norm).
   - Selects PCM or VF interface.

3. Option 05, DROP & INSERT: Option 05 is built into the cover of the 966A test set. It allows the 966A Trunk Signaling Analyzer to interface with PCM carriers at the DS-1 (1.544 MBPS) rate. The Option 05 can monitor, transmit or receive DS-1 signals. It indicates bipolar error, carrier loss, frame loss, loss of signaling frame and remote terminal alarm. It has channel and A & B bit access on D1D, D2, D3 and D4 facilities.

1.13 All three All three options of the 966A (03, 04 and 05) are discussed throughout this publication, even though your set cannot include both options 04 and 05.

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1.14 When equipped with the DS-1 PCM RECEIVERS (Option 04 & 05), the 966A is particularly useful for the cutover of digital switches. The test set detects signaling problems being transmitted or received by the switch. Pre-cutover testing, using the 966A, can eliminate many problems prior to turnup. Translation problems can also be identified and solved by using the 966A.

D. Specifications

1.15 Specifications of the Model 966A Trunk Signaling Analyzer are shown in Table B.

TABLE B
SPECIFICATIONS

General	
Type of Pulsing	Multifrequency, Dual Tone Multifrequency or Dial Pulse DTMF (Option 03)
MF Digits Received	Digits 0 thru 9, KP, ST, STP, ST2P and ST3P
DTMF Digits Received (Option 03)	Digits 0 thru 9, *, #, A, B, C and D
Functions	MONITOR, SIMULATE WINK, SIMULATE DELAY DIAL and SIMULATE BYLINK
Interface	Analog or Digital (DS-1) (Option 04) (Option 05)
Digit Capacity	Six 16 digit Records (96 digits total)
Pulsing Formats	DDD, ANI, CCC, CAMA, TSPS, IDDD and EA
Type of Supervision	Loop or E&M
Supervision Sensors	
Loop Voltage	>19V = ON-HOOK <3V = OFF-HOOK 3V to 19V = no indication
E Lead Voltage	>40V = ON-HOOK <6V = OFF-HOOK 6V to 40V = no indication
M Lead Voltage	<4.2V = ON-HOOK >22V = OFF-HOOK 4.2V to 22V = no indication

TABLE B (Continued)
SPECIFICATIONS

Input Impedance	
TR	MONITOR; 650K Nominal SIMULATE (2-Wire): 900 ohms +/- 5% SIMULATE (4-Wire): 600 ohms +/- 5%
T1R1	MONITOR: 300K Nominal SIMULATE (4-Wire): 600 ohms +/- 5%
E Lead	MONITOR: 35K ohms SIMULATE (ON-HOOK): Open SIMULATE (OFF-HOOK): Ground
M Lead	MONITOR: 35k ohms SIMULATE (ON-HOOK): Ground SIMULATE (OFF-HOOK): Battery
Option 04/05	100 ohms Terminating 1000 ohms Bridging
Output Impedance	
Option 05	100 ohms
Simulate Timing	
Wink Start	Line Seize 200 ms idle 150 ms OFF-HOOK
Delay Dial	Line Seize 80 ms idle 150 ms OFF-HOOK
Call-Completion Tone	
Frequency	1004 Hz +/- 1 Hz
Level Accuracy	+/- .25 dB
2-Wire Level	0 dBm
4-Wire Originating Level	+7 dBm
4-Wire Terminating Level	-16 dBm
Multifrequency (MF) Receiver	Each parameter of MF receiver performance is specified with all other parameters held to the following standard condition: MF Tone Level -6 dBm per tone MF Tone Length 70 ms MF Tone Spacing 70 ms
Detected Frequencies	Tone Accuracy +/- 1 Hz Standard MF: 700, 900, 1100, 1300, 1500, and 1700 Hz
Codes Detected	1 2 3 4 5 6 7 8 9 0 KP ST STP ST2P ST3P
MF Tone Level	-34 dBm to +6 dBm per tone
MF Tone Length	25 ms minimum, no maximum
MF Tone Spacing	25 ms minimum, no maximum

TABLE B (Continued)
SPECIFICATIONS

Multifrequency (MF) Receiver (Continued)	
Twist	8 dB maximum
Receiver Bandwidth	Detect for tones within ±2% No Detect for tones outside ±6%
Signal Dropout	20 ms without registering a new digit
Wink Recovery	30 ms maximum
Dual Tone Multifrequency (DTMF) Receiver (Option 03)	Each parameter of DTMF receiver performance is specified with all other parameters held to the following standard conditions: DTMF Tone Level −6 dBm per tone DTMF Tone Length 50 ms DTMF Tone Spacing 50 ms Tone Accuracy ±1 Hz
Detected Frequencies	Standard DTMF: 697, 770, 852, 941, 1209, 1336, 1477, and 1633
Codes Detected	1 2 3 4 5 6 7 8 9 0 * # A B C D
DTMF Tone Level	−36 dBm to +8 dBm per tone
DTMF Tone Length	30 ms minimum; no maximum
DTMF Tone Spacing	30 ms minimum; no maximum
Twist	10 dB
Receiver Bandwidth	Detect for tones within ±2.5% No Detect for tones outside ±3.5%
Pulse Limit Test	Used for Multifrequency (MF) and Dual Tone Multifrequency (DTMF) only (Option 03)
Amplitude Range	−24 dBm to +4 dBm
Amplitude Resolution	2 dB steps
Amplitude Accuracy	±.5 dB
Amplitude Detector	Average responding digital voltmeter calibrated in RMS
Length Range	30 ms to 120 ms
Length Resolution	5 ms steps
Length Accuracy	±1 ms

TABLE B (Continued)
SPECIFICATIONS

Dial Pulse (DP) Receiver	
PPS Range	7-20 pulses per second
% Break Range	7 pps 24%-64% 10 pps 34%-70% 13 pps 40%-76% 15 pps 44%-73% 20 pps 56%-69%
Interdigital Time	260 ms minimum
Power Requirements	
Input Power	115 VAC +/- 10%; 47-440 Hz; 30 watts maximum
Environmental	
Ambient Temperature	+32° to +120° F (0° to + 50° C)
Relative Humidity	0 to 99% No condensation
Mechanical	
Dimensions (HXWXD)	7.0 X 11.0 X 7.0 inches 17.8 X 27.9 X 17.8 centimeters
With Option 04	8.5 X 11.0 X 7.0 inches 21.6 X 27.9 X 17.8 centimeters
With Option 05	11.0 X 11.0 X 7.0 inches 27.9 X 27.9 X 17.8 centimeters
Weight	12 lbs. (5.5 Kgs)
With Option 04	15 lbs. (6.8 Kgs)
With Option 05	15 lbs (6.8 Kgs)
Circuit Access	310 type jacks: TR and T1R1, E&M
With Option 04	310 type jacks: TR and T1R1, DS-1 INPUT
With Option 05	310 type jacks: TR, T1R1, E&M, (EXTERNAL), TIP=A, RING =B (REC A/B), IN, OUT (PCM), XMIT
Controls	Pulse Limit Test: TEST, READ, (F) OFF, SET MS, SET DBM Trunk Type: (1) LOOP NORMAL, (2) LOOP REVERSE, (3) E&M ORIGINATING, (4) E&M TERMINATING Function: MONITOR, SIMULATE WINK, SIMULATE DELAY DIAL, SIMULATE BYLINK Display: REC 1, REC 2, BOTH Mode: NORM, IDDD Reset: AUTO, HOLD, MANUAL Other: EXAMINE ERROR, VOLUME, POWER
Controls with Option 04	TERM/BRIDGE, TR/T1R1, CHANNEL SELECT, D1D/D2/D3/D4, CCIS/NORM, A BIT/B BIT/SIG OUT, PCM/VF
Controls with Option 05	TERM/BRIDGE, DROP & INSERT/MON., A/B, EXT/INT. D1D/D2/D3/D4, 1-24, A,B

TABLE B (Continued)
SPECIFICATIONS

Mechanical (Continued)	
Indicators	Pulse Limit Test: TEST, READ, (F) OFF
	Trunk Type: (1) LOOP NORMAL, (2) LOOP REVERSE, (3) E&M ORIGINATING, (4) E&M TERMINATING
	Function: MONITOR, SIMULATE WINK, SIMULATE DELAY DIAL, SIMULATE BYLINK
	Display: REC1, REC2, BOTH
	Mode: NORM, IDDD
	Reset: AUTO, HOLD
	Originating: OFF-HOOK, ON-HOOK
	Terminating: OFF-HOOK, ON-HOOK
	REC1, REC2, SHORT, LOW, ERROR, OVER-FLOW
	700, 900, 1100, 1300, 1500, 1700
Indicators with Option 04	NO PCM, BIPOLAR ERROR, TERM FRAME LOSS, TERM FRAME ERROR, REMOTE ALARM, POWER ON, CHANNEL
Indicators with Option 05	BIPOLAR ERROR, CARRIER LOSS, FRAME LOSS, LOSS OF SIGNALING FRAME, REMOTE TERMINAL ALARM, RECEIVE SUPERVISION AB
Miscellaneous	
Display	16 red, seven-segment, LED digits .056 inches high (additional digits up to 96 are alternatively displayed)
Loudspeaker	Monitoring incoming digit sequences and circuit activity.
-48V OUT jack	-48V supply @ 1 amp

2. DESCRIPTION

A. General

2.01 The Model 966A Trunk Signaling Analyzer is designed to receive, store, display and analyze MF, DTMF (Option 03) and DP signaling on both analog and digital (Option 04, 05) trunks. Both two-wire and four-wire circuits equipped with either LOOP or E&M supervision may be tested.

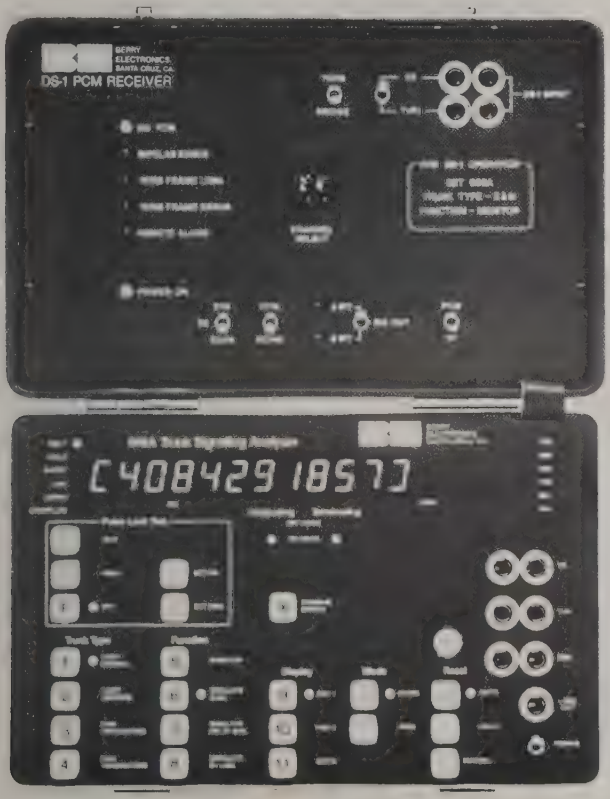


Figure 1. Model 966A Trunk Signaling Analyzer

2.02 Figure 1 is a photograph of the 966A test set. The 966A test set may be used as a stand-alone portable or in combination with other BERRY ELECTRONICS test sets.

2.03 The DS-1 PCM RECEIVER (Option 04) allows the operator to access a DS-1 bit stream (1.544 MBPS) and to select any channel (time slot) for testing. This enables monitoring of both Originating and Terminating digital trunks at the DSX-1 jack fields. Option 04, when provided, is located in the cover of the 966A.

2.04 The DS-1 (Option 05) DROP & INSERT allows the operator to access a DS-1 bit stream (1.544 MBPS) and to select any channel (time slot) for testing. This enables monitoring, transmitting and receiving of DS-1 signals on both Originating and Terminating digital trunks. Option 05, when provided, is located in the cover of the 966A.

2.05 Various signaling problems such as short-duration or low-level tone pulses, mutilated MF digits (digits with only one MF tone or more than two MF tones), missing KP or ST codes and improper supervision are automatically detected and displayed.

2.06 The 966A receives and displays up to 96 digits of Multifrequency (MF), Dual Tone Multifrequency (DTMF Option 03) and Dial Pulse (DP) pulsing. Originating and Terminating office supervision is continuously displayed before, during and after outpulsing has occurred. Individual MF and DTMF pulses are measured for length and amplitude and may be checked against limits. Mutilated MF are recorded as errors and may be individually examined for tone content. Missing KP and ST codes are also automatically identified.

2.07 Advanced microprocessor techniques are used in the 966A to produce an instrument that is extremely versatile and yet easy to use. Front panel controls are logically grouped according to function. LED's are used to indicate which control functions have been selected.

2.08 The five keys in the "Pulse Limit Test" group are used to measure MF and DTMF (Option 03) tone pulses against operator set duration and transmission level limits. The TEST, READ or OFF key may be selected as desired. The SET MS and SET DBM keys establish the operator-set limits. The FEATURE (F) key enables the four "Trunk Type", four "Function" and three "Display" keys to perform second functions, i.e., the selection of FEATURE 1 through FEATURE 11.

2.09 The keys in the "Trunk Type" group are used to select the type of supervision on the trunk to be tested. LOOP NORMAL, LOOP REVERSE, E&M TERMINATING (Test set in Terminating office) may be chosen. The "Trunk Type" keys are dual purpose keys and are also used to select FEATURES 1, 2, 3 or 4. The four FEATURES are:

- FEATURE 1: MISSING KP/ST DETECT
- FEATURE 2: NO KP REQUIRED
- FEATURE 3: MISSING ANSWER SUPERVISION DETECT
- FEATURE 4: TOUCH-TONE® ENABLE

WARNING: DTMF receivers remain open during testing and may cause voice-hits.

2.10 Trunk supervision is shown by two sets of ON-HOOK and OFF-HOOK LED indicators. One set is for the Originating office; the other set for the Terminating office. These indicators are connected to the appropriate supervision sensors as selected by the "Trunk Type" keys.

2.11 The keys in the "Function" group are dual purpose keys. They are used to select the type of operation desired as well as to select FEATURES 5, 6, 7, or 8. In MONITOR, the 966A is bridged across the trunk and can be used to display the complete pulsing and supervision sequence present on a working trunk. Missing digits, incorrect translation, and improper supervision sequence are easily detected. High input impedance ensures that the 966A causes no circuit loading. To monitor an EQUAL ACCESS FEATURE GROUP D call, it is necessary to select the number of records per call you expect by selecting FEATURE 5, 6, 7, or 8 as appropriate. The features are:

- FEATURE 5: ABC ENABLE
- FEATURE 6: EQUAL ACCESS calls having one record
- FEATURE 7: EQUAL ACCESS calls having two records
- FEATURE 8: EQUAL ACCESS calls having three records

2.12 When testing analog trunks, the SIMULATE function acts as the Terminating office and provides battery and supervision just as a real Terminating office would. All types of Terminating offices can be simulated including WINK start, DELAY DIAL start, BYLINK (Immediate Dial) and EA (Equal Access). The 966A in SIMULATE WINK can be used to display the Complete Pulsing Format and supervision sequence present on a working trunk.

2.13 For two-stage pulsing such as ANI, CAMA, TSPS or IDDD, the 966A provides the correct supervision for initiating both first-stage and second-stage pulsing. At the conclusion of pulsing, the 966A provides answer supervision and a 1004 Hz audible tone to indicate call completion. The level of this tone is automatically set for the type of trunk being tested. 0 dBm is used for Originating four-wire trunks; and -16dBm is used for Terminating four-wire trunks. 600 ohm impedance is automat-ically selected for all four-wire measurements while 900 ohms is used for all two-wire measurements.

2.14 The three keys in the "Display" group are used to select single- or two-stage display as required by the trunk being tested. REC 1 (Record 1) is selected for single-stage pulsing such as a simple interoffice call. Pulsing is displayed on the 16-bit MAIN DISPLAY as received. For records over 16 digits, the OVERFLOW indicator illuminates and up to 16 additional digits can be stored in memory. These digits can be viewed by depressing the EXAMINE ERROR key. When in REC 1 and any SIMULATE function, the 966A simulates a Terminating office equipped to receive single-stage pulsing. The DISPLAY keys are dual purpose keys and are also used to select FEATURES 9, 10, and 11. The three FEATURES are:

- FEATURE 9: WINK back after RECORD 1
- FEATURE 10: WINK back after RECORD 2
- FEATURE 11: WINK back after RECORD 3

2.15 For two-stage pulsing such as ANI, TSPS, or IDDD, each stage is treated as a separate record. To record both stages, the BOTH key is selected. The first stage is stored in REC 1 and the second stage in REC 2. For example, in TSPS, the called number would be in REC 1 and the calling number in REC 2. At the completion of pulsing, the MAIN DISPLAY cycles every 4 seconds between REC 1 and REC 2. The record being displayed is indicated by the REC 1 and REC 2 LED indicators located to the left of the MAIN DISPLAY. If desired, either record can be continuously displayed by using the REC 1 or REC 2 keys. When in BOTH and any SIMULATE function, the 966A simulates a Terminating office equipped to receive two-stage pulsing.

2.16 To record ABC or CCC calls, Feature 4 (DTMF enable) and Feature 5 (ABC calling) must be selected. The called number is stored in REC 1, the calling number is stored in REC 2 and the credit card number is stored in OVERFLOW. To view the records, select BOTH and step through the EXAMINE ERROR key.

2.17 The two keys in the "Mode" group are used to select for operation with NORMAL or International Direct Distance Dialing (IDDD) trunks. Normal trunks are the type found throughout the United States and Canada. IDDD trunks are those used for calling outside North America (International Gateway trunks). The 966A is compatible with both type of trunks.

2.18 The 966A can be automatically or manually reset as selected by the keys in the "Reset" group. If AUTO is selected, the test set is automatically reset at the beginning of each new call. During reset, both pulsing records and the Main Display are cleared. To save a pulsing record for analysis, the HOLD key is used to inhibit automatic reset. When HOLD is selected, the 966A can only be reset by using the manual reset key.

2.19 A unique feature of the 966A is the ability to trap intermittent signaling problems. The instrument does this by automatically jumping from AUTO reset to HOLD when a problem condition is detected. These conditions include short-duration or low-level MF and DTMF (Option 03) tone pulses, mutilated MF digits, missing KP and ST codes and missing answer supervision.

2.20 The 966A can store up to 96 digits of either MF or DTMF signals at one time. Only 7 DP digits are accepted, or 10 if the second digit is "0" or "1". Up to 96 DP digits can be stored if

the 966A is in the monitor mode, however. Up to 16 digits can be displayed at one time. The first 16 are shown when the REC 1 key under "Display" is depressed. The second 16 digits are shown when the REC 2 key under "Display" is depressed. If the OVERFLOW indicator is illuminated, indicating additional digits, the BOTH key may be depressed and the display will alternately show REC 1, REC 2, and OVERFLOW at four second intervals. Records can also be viewed by selecting the BOTH key and stepping through using the EXAMINE ERROR key.

2.21 Frequency indicators are located to the right of the MAIN DISPLAY. Six LED indicators represent the different tones present in MF signaling (1700, 1500, 1300, 1100, 900, and 700 Hz). These are used to display the tones present in mutilated MF digits when the EXAMINE ERROR procedure is through. An MF tone is considered mutilated when only one MF tone or more than two MF tones are present.

2.22 The 966A is connected to the trunk to be tested by means of the 310-type jacks on the face of the unit. Appropriate test cords must be used.

2.23 The Model 966A Trunk Signaling Analyzer operates on 115 VAC. A standard line cord is provided. Negative 48V DC is provided at the -48 OUT jack and may be used as required for external devices, e.g. M lead make busy.

2.24 The Model 966R Trunk Signaling Analyzer is not provided with a -48 OUT jack.

B. Physical Description

2.25 The Model 966A Trunk Signaling Analyzer is a portable test set equipped with a carrying handle attached to the cover. It is 7 inches high, 11 inches wide and 7 inches deep (17.8 X 27.9 X 17.8 centimeters). It weighs 12 pounds (5.5 Kgs). When the DS-1 PCM RECEIVER (Option 04) is provided, the height is 8.5 inches (21.6 centimeters) and the weight is 15 pounds (6.8 Kgs). When the DROP & INSERT UNIT (Option 05) is provided, the height is 111.0 inches (27.9 centimeters) and the weight is 19 pounds (6.6 Kgs).

2.26 The 966R Trunk Signaling Analyzer is a rack mountable test set which will fit either a 19- or 23-inch space. Refer to section R for dimensions and weight.

2.27 The 966A case is equipped with two D rings for attaching a ladder strap. The ladder strap is furnished with the test set.

2.28 All connections to the 966A are made via the seven front panel jacks. These jacks accept 310 type plugs. AC power is connected by means of the receptacle on the rear of the test set. An AC line which meets with this receptacle is included with the 966A.

2.29 The DS-1 CM RECEIVER (Option 04) or DROP & INSERT (Option 05), when provided, are enclosed in the cover of the 966A. A 16-conductor RIBBON CABLE is provided to transfer power and signaling information between the 966A and the DS-1 PCM RECEIVER (Option 04), or DROP & INSERT (Option 05).

2.30 The chassis and case are constructed of heavy gauge aluminum alloy. Four non-marring rubber feet are provided on the bottom of the case.

C. 966A Front Panel

2.31 The DS-1 PCM RECEIVER (Option 04) and the Model 966A Trunk Signaling Analyzer front panel layouts, switches, jacks, controls and digital display readout are shown in Figure 2. The circled callout numbers in the figure correspond with the circled callout numbers in the following text.

966A TRUNK SIGNALING ANALYZER

(1) **MAIN DISPLAY** consists of 16 seven-segment red LED read outs. Up to 16 digits of either MF, DTMF (Option 04) or DP pulsing can be displayed at one time. Internal storage in the 966A permits recording of up to 96 digits of pulsing. For display purposes, the pulsing recorded is stored as two separate 16-digit records (REC 1 and REC 2). REC 1 is used to display single-stage outpulsing up to 16 digits. The extra digits are stored in OVERFLOW and the second stage in REC 2. Pulsing formats with more than two records, such as credit card calls, will store the third record in the OVERFLOW Record. The main display is also used to indicate the Pulse and level limits selected when using the Pulse Limit Test.

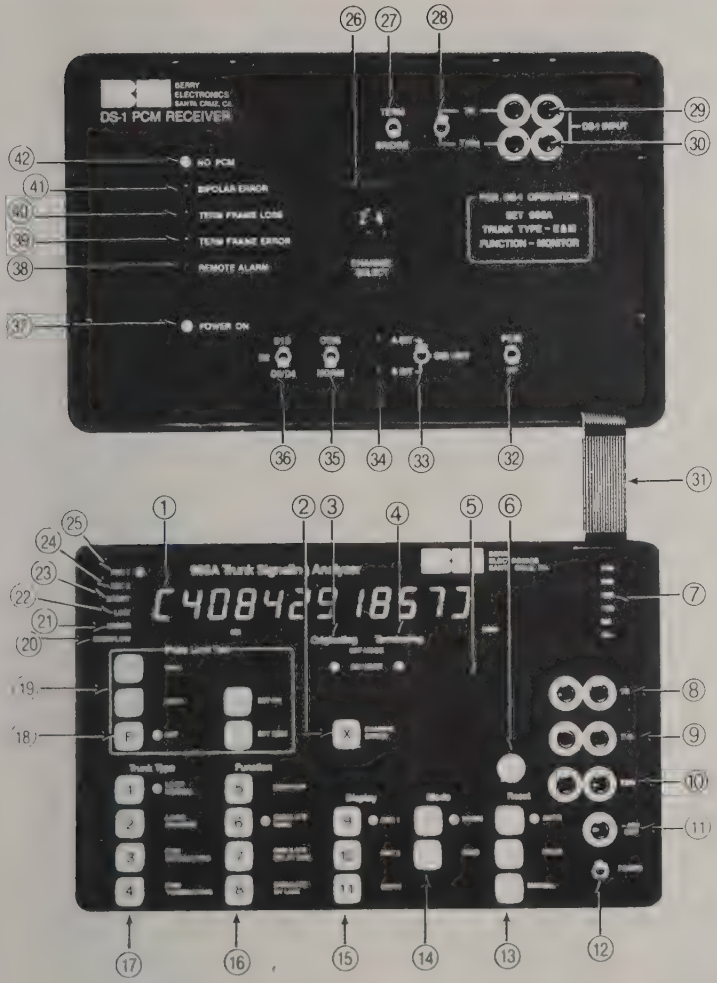


Figure 2. DS-1 PCM RECEIVER (Option 04) and 966A Trunk Signaling Analyzer Front Panels

(2) **EXAMINE ERROR** key is a dual purpose key. During FEATURE GROUP D TESTING (when you select FEATURE 6 - 11 or ABC--4, 5 and 8), the key becomes an "X" key and can be used to examine record 1, 2, or 3, or overflow records as needed simply by operating the key. During "normal" trunk testing, the key is used for examining the Pulse Limit Test failures and to determine exactly the tones present in mutilated MF digits. When depressed and held, the EXAMINE ERROR key commands the 966A to flash the failing digit being examined and show the type of failure on the appropriate indicators. SHORT and/or LOW indicators are used for Pulse Limit Test failures and 1700, 1500, 1300, 1100, 900, and 700 indicators are used for mutilated MF digits. Each failed digit is examined and flashed for four seconds starting from the left of the MAIN DISPLAY and advancing one digit at a time to the right. This process starts and continues anytime EXAMINE ERROR key is depressed and held except during FEATURE GROUP D testing, as mentioned above.

(3)(4) Originating and Terminating **OFF-HOOK** and **ON-HOOK** red LED indicators are used to display the OFF-HOOK and ON-HOOK status of the Originating and Terminating offices of the trunk under test.

(5) **LOUDSPEAKER** for monitoring signaling tones and circuit activity.

(6) **VOLUME** control for setting audio output level.

(7) **1700, 1500, 1300, 1100, 900, 700,** red LED indicators represent the different tones present in MF pulsing (1700 Hz, 1500 Hz, 1300Hz, 1100 Hz, 900 Hz, 700 Hz). These are used to indicate the tones present in mutilated MF digits when the EXAMINE ERROR key is depressed. These lamps only indicate the tones present for mutilated digits (digits with only one MF tone or more than two MF tones).

(8) **TR** jacks are used to connect the tip and ring of the trunks under test to the 966A. These jacks are wired in parallel so that a "loop thru" type connection can be made. Jack spacing allows the use of double plugs if desired. For single-ended applications, either jack can be used.

(9) **T1R1** jacks are used to connect the tip 1 and ring 1 of the trunk under test to the 966A. These jacks are wired in parallel for "loop thru" or single-ended use.

(10) **E & M** jacks are used to connect the E&M leads of the trunk under test to the 966A. The E leads should be connected to the tip of the jack and the M lead to the ring. These jacks are wired in parallel.

(11) **-48V OUT** jack may be used to supply battery to external equipment or to an M lead for OFF-HOOK condition if required. This jack is not provided on the Model 966R.

(12) **POWER** switch applies power to the 966A and initiates the microprocessor self-test. Following the self-test, the 966A will set itself up in the most commonly used mode of operation.

(13) **Reset key** group is used to select the method of resetting the 966A. During a reset, the MAIN DISPLAY, both pulsing records, and the four LED indicators designated SHORT, LOW, ERROR and OVERFLOW are all cleared. For SIMULATE WINK, SIMULATE DELAY DIAL and SIMULATE BYLINK functions, answer supervision and the 1004 Hz call-completion tone are also terminated when the 966A is reset. The three Reset keys are:

1. **AUTO**

   When selected, the 966A is automatically reset whenever a new MF, DTMF (Option 03) or DP record is received. The 966A can also be manually reset while in AUTO by using the MANUAL reset as described below.

   Certain pulsing errors cause the 966A to automatically jump from AUTO to HOLD. These include; OVERFLOW which occurs if more than 16 digits are received for one record; mutilated MF pulses (pulses which consist of one MF tone or more than two MF tones); or reception of an MF or DTMF (Option 03) pulse that is lower and/or shorter than the operator-set limits during a Pulse Limit Test. This feature of auto-

matically jumping from AUTO to HOLD is particularly useful for trapping intermittent pulsing failures.

2. **HOLD**

   When selected, prevents the 966A from being automatically reset by the next record received as in AUTO. Useful for holding records to be analyzed. In HOLD, the 966A can only be reset by using the MANUAL reset described below.

3. **MANUAL**

   Momentary action key used to manually reset the 966A.

(14) Mode key group is used to select the 966A operating mode for use with either NORMAL or International Direct Distance Dialing (IDDD) trunks. The two Mode keys are:

1. **NORM**

   Used for all trunks except IDDD. In dual-stage outpulsing SIMULATE operation (CAMA, TSPS, etc.), second-stage outpulsing is initiated with a Terminating office OFF-HOOK. Also, all MF pulsing records must begin with KP (KP1) and end with ST, STP, ST2P, or ST3P. (Note: FEATURE 1 allows the reception of MF pulsing without beginning with KP (KP1) and ending with ST, STP, ST2P, or ST3P).

2. **IDDD**

   Used for International Direct Distance Dialing trunks either inside or outside the North American switched network. IDDD trunks inside the North American network connect domestic toll centers with International Switching Centers (ISCs). These trunks use two-stage MF pulsing with a momentary Terminating office OFF-HOOK (WINK) between stages instead of a continuous OFF-HOOK as employed by CAMA or TSPS. In the IDDD Mode, the 966A provides this same WINK in all two-stage SIMULATE functions. In this way, a 966A can simulate an ISC.

   IDDD trunks outside the North American network connect ISCs in North America with ISCs in other countries. These trunks use a slightly different version of MF pulsing known as CCITT Signaling System No. 5. In this system, MF pulsing records can begin with either KP1 (KP) or KP2 (ST2P) and must end with ST. In the IDDD Mode, the 966A follows the same conventions as CCITT Signaling System No. 5 for beginning and ending records.

(15) Display key group is used to select the 966A method of operation for either single- or multiple-stage outpulsing trunks. The keys select which RECORD is shown in the MAIN DISPLAY. The three Display keys are:

1. **REC 1**

   Used for single-stage outpulsing trunks. Pulses are stored in RECORD 1 and displayed as received. Also used to select RECORD 1 for MAIN DISPLAY.

   When REC 1 is selected and any SIMULATE function chosen, the 966 simulates a Terminating office equipped to receive single-stage outpulsing. Answer supervision and 1004 Hz call-completion tone are sent after a single stage of pulsing for this condition.

2. **REC 2**

   Used for dual-stage outpulsing trunks and to select RECORD 2 for the MAIN DISPLAY. The first stage of outpulsing is recorded in RECORD 1 and displayed as received. The second stage is recorded in RECORD 2 and displayed as received. At the completion of pulsing, RECORD 2 is shown on the MAIN DISPLAY. The outpulsing received in RECORD 1 can be reviewed by selecting REC 1. This is also used to display the third record of a three-part call.

3. **BOTH**

   Used for three-stage outpulsing trunks and to command alternate display of RECORD 1 and RECORD 2 every 4 seconds. Reception of outpulsing is identical to REC 2.

(16) Function key group is used to select the Function of the 966A. The 966A can be used either as a pulsing and supervision monitor or it can be used to actually simulate the Terminating office. Three different types of simulation are provided: SIMULATE WINK, SIMULATE DELAY DIAL, and SIMULATE BYLINK (IMMEDIATE DIAL). In simulate functions, the test set acts as the Terminating office and provides battery and supervision just as the real Terminating office would. The four Function keys are:

1. **MONITOR**

   When selected, allows the 966A to MONITOR trunks on a high-impedance bridging basis to insure no interference with normal trunk operation.

2. **SIMULATE WINK**

   When selected, the 966A simulates a WINK start Terminating office, i.e., 200 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK of 150 ms (WINK). At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by the Trunk Type group keys.

3. **SIMULATE DELAY DIAL**

   When selected, the 966A simulates a DELAY DIAL start Terminating office, i.e., within 80 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK (Delay Dialing Signal) of 150 ms. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by the Trunk Type group keys.

4. **SIMULATE BYLINK**

   When selected, the 966A simulates a BYLINK (IMMEDIATE DIAL) Terminating office, i.e., Terminating office supervision remains ON-HOOK until outpulsing is completed. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop and E&M signals are provided as selected by the Trunk Type group keys.

(17) **Trunk Type** key group is used to select the type of trunk that is under test. This refers to the type of trunk supervision. These keys also serve as dual purpose keys to select special FEATURES. The special FEATURES are described in callout item 35. The four Trunk Type keys are:

1. **LOOP NORMAL**

   Selected for trunks with Loop Normal supervision. Loop Normal trunks have Battery on Ring for terminating office ON-HOOK and Battery on Tip for Terminating office OFF-HOOK.

2. **LOOP REVERSE**

   Selected for trunks with Loop Reverse supervision. Loop Reverse trunks have Battery on Tip for Terminating office ON-HOOK and Battery on Ring for Terminating office OFF-HOOK.

3. **E&M ORIGINATING**

   Selected for trunks with E&M supervision when the test set is in the Originating office. In the Originating office, the M lead is used for Originating office supervision and the E lead is used for Terminating office supervision.

4. E&M TERMINATING

Selected for trunks with E&M supervision when the test set is in the Terminating office. In the Terminating office, the M lead is used for Terminating office supervision and the E lead is used for Originating office supervision.

(18) The F key is used to select one of several special FEATURES. The F key is located in the Pulse Limit Test key group and initiates the FEATURE selection process. Individual FEATURES are selected by the numbered keys located in the Trunk Type, Function, and Display key groups. FEATURES 1 through 4 are associated with normal type trunk testing. They are selected by first activating the "F" key and then selecting 1 through 5. FEATURES 6 through 11 are associated with testing the FEATURE GROUP D SERVICE TRUNKS for "EQUAL ACCESS" and require pressing the "Simulate Wink" key before pressing the "F" key to activate them. The FEATURES are:

FEATURE 1: MISSING KP/ST DETECT

Detects and holds MF pulsing records which do not begin with KP and end with ST, STP, ST2P or ST3P. (Note: FEATURE 1 disables TOUCH-TONE* [DTMF Option 03] reception when selected).

FEATURE 2: NO KP REQUIRED

Accepts MF records without the normally required beginning KP. (Note: FEATURE 2 disables DTMF [Option 03] reception when selected).

FEATURE 3: MISSING ANSWER SUPERVISION DETECT

Detects and holds pulsing records when the Originating office remains OFF-HOOK for over two minutes without the Terminating office ever going OFF-HOOK.

FEATURE 4: Option 03 Enable

Allows unit to accept DTMF signaling.

FEATURE 5: AUTOMATICALLY BILLED CALLS (ABC) DISPLAY

Records and displays the three-record pulsing format employed in Automatically Billed Calls (ABC). The First two records are MF for the Called and Calling number. The third record is DTMF (Option 03) for the credit card number.

FEATURE 6: RECEIVE 1 EA RECORD

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting one record per call.

FEATURE 7: RECEIVE 2 EA RECORDS

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting two records per call.

FEATURE 8: RECEIVE 3 EA RECORDS

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting three records per call.

FEATURE 9: WINK AFTER 1st RECORD

When testing the FEATURE GROUP D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 1.

FEATURE 10: WINK AFTER 2nd RECORD

When testing the FEATURE GROUP D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 2.

FEATURE 11: WINK AFTER 3rd RECORD

When testing the FEATURE GROUP

D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 3.

(19) **Pulse Limit Test** key group is located on the left side of the panel enclosed in a white outline. When activated, the Pulse Limit Test allows the operator to set predetermined limits for amplitude and width of MF and/or DTMF (Option 03) pulses and to compare these limits with the actual amplitude and width of each MF or DTMF (Option 03) pulse received. When pulses fail to meet these limits, the LOW and/or SHORT LED indicators located to the left of the MAIN DISPLAY are illuminated as appropriate. By using the EXAMINE ERROR key, the operator can tell which pulses failed which limits. Because the 966A actually measures and stores the amplitude and width of each MF and DTMF pulse received, it is possible to determine the values for individual pulses after the record has been captured. This is done by changing the amplitude and width limits and noting which pulses fail which limits. For example, if a particular MF digit causes the LOW indicator to illuminate when pulse amplitude limit is set to -6 dBm, but it remains dark at -8 dBm, then the amplitude of that pulse is in the range of -8 to -6 dBm. The five Pulse Limit Test keys are:

1. **TEST**

   Activates the Pulse Limit Test feature. Any MF or DTMF (Option 03) pulses which fail to meet the operator-set amplitude and width limits cause the LOW and/or SHORT LED indicators to illuminate as appropriate and the 966A to jump from AUTO to HOLD. This feature is useful for trapping intermittent pulsing failures.

2. **READ**

   Commands the MAIN DISPLAY to indicate the present MF and DTMF (Option 03) pulse limits used in the Pulse Limit Test. The pulse width limit is shown in milliseconds above the MS legend and the amplitude limit is shown in dBm above the DBM legend. Shown below is an example of using the READ command to view the Pulse Limit Test limit settings.

3. **OFF**

   Deactivates the Pulse Limit feature. Also used to initiate the FEATURE selection mode. See item 35.

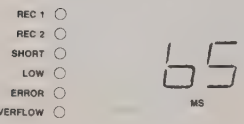
4. **SET MS**

   Sets the pulse width limit. Each time the SET MS key is pressed, the MS display value increases by 5 milliseconds. The pulse width may be set over a range of 30 ms to 120 ms. Pulse width may be set in the TEST or READ condition. READ is used to set the desired test value limit. TEST can be used to determine the exact value of an MF or DTMF (Option 03) pulse by increasing the pulse width limit and noting when the SHORT indicator illuminates.

5. **SET DBM**

   Sets the pulse amplitude limit. Each time the SET DBM key is pressed, the DBM display value increases 2 dBm. The pulse amplitude may be set over a range of -24 dBm to +4 dBm. Pulse amplitude may be set in the TEST or READ condition. READ is used to set the desired test value limit. TEST can be used to determine the exact value of an MF or DTMF (Option 03) pulse by increasing the pulse amplitude limit and noting when the LOW indicator illuminates.

NOTE: All keys, except SET MS, SET DBM, EXAMINE ERROR and MANUAL have an associated red LED. The LEDs, when illuminated, indicate to the operator which keys have been selected.



(20) **OVERFLOW** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that more than 16 digits have been entered into a record. Also indicates the third record of a credit card call (CCC).

(21) **ERROR** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates an incorrect entry format or the incorrect use of controls.

(22) **LOW** red LED indicator located to the left of the MAIN DISPLAY. Only operates when the Pulse Test Limit is in the TEST condition. When illuminated, indicates that that an MF or DTMF (Option 03) pulse has been received that is lower than the operator-set Pulse Limit Test value.

(23) **SHORT** red LED indicator located to the left of the Pulse Test Limit is in the TEST condition. Indicates that an MF or DTMF (Option 03) pulse has been received that is shorter that the operator-set Pulse Limit Test value. Also used to indicate that the digit being examined, by the EXAMINE ERROR key, is shorter that the Pulse Limit Test value.

(24) **REC 2** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that RECORD 2 is being displayed.

(25) **REC 1** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that RECORD 1 is being displayed or, if no display is present, indicates that RECORD 1 will be the next record displayed.

DS-1 PCM RECEIVER (Option 04)

(26) **CHANNEL SELECT** thumbwheel switch allows any channel (1-24) to be selected for testing.

(27) **TERM/BRIDGE** switch controls the input impedance of the TR and T1R1 jacks. The input impedance is 100 ohms for the term position, and 1000 ohms for the BRIDGE position.

(28) **TR/T1R1** switch selects either the TR of T1R1; DS-1 INPUT jacks.

(29) (30) **TR** jacks are used for connecting to the monitoring outgoing (send or transmit) side of a DS-1 line. T1R1 jacks are used for connecting to the monitoring incoming (receive) side of a DS-1 line. The two sets of parallel-wired jacks allow the convenient connection of other optional test equipment for either direction of transmission.

(31) **RIBBON CABLE** (16-conductor) is used to transfer power and signaling information between the DS-1 PCM RECEIVER (Option 04) and the 966A.

(32) **PCM/VF** switch is used to select the output of the DS-1 PCM RECEIVER (Option 04). The PCM position selects the decoded built-in Dial Pulse (DP) signaling output normally used on digital carrier trunks. The VF position selects the decoded channel voice frequency output. This position is used for MF and/or DTMF (Option 03) signaling and monitoring.

(33) (34) **A BIT/B BIT; SIG OUT** switch selects either the A or B signaling bit output. The red A BIT and B BIT LED's indicate the status of the signaling bits. When a one (1) is received, the LED is illuminated. If a zero (0) is received, the LED remains dark. The 966A must be set to either E and M Originate or Terminate for the SIG OUT switch to operate properly.

(35) **CCIS/NORM** switch selects the type of decoding. The CCIS position is used for trunks equipped with Common Channel interoffice Signaling. All bits are decoded as voice frequency information. In the NORM position, signaling information is decoded from every sixth frame.

(36) **D1D/D2/D3/D4** switch is used to select the channel sequence or bank type being tested.

(37) **POWER ON** red LED, when illuminated, indicates a remote alarm condition is being suppplied to the DS-1 PCM RECEIVER.

(38) **REMOTE ALARM** red LED, when illuminated, indicates a remote alarm condition is being received from the remote office (bit 2 is suppressed on all channels).

(39) **TERM FRAME ERROR** red LED, when illuminated, indicates a framing bit has been received which is not the inverse of the previous framing bit, i.e., a frame slip has occurred.

(40) **TERM FRAME LOSS** red LED, when illuminated, indicates the DS-1 PCM RECEIVER

is out of frame and is in the process of trying to reframe on the incoming signal, i.e., a misframe condition exists.

(41) **BIPOLAR ERROR** red LED, when illuminated, indicates the receipt of two consecutive positive or negative bits.

(42) **NO PCM** red LED, when illuminated, indicates a loss of the DS-1 (1.544 MBPS) bit stream input.

3. OPERATION

A. General

3.01 This section provides instructions for using and operating the Model 966A Trunk Signaling Analyzer. The operating procedures include a brief description of the tests. Information on the three types of signaling systems tested by the 966A is also presented.

B. MF Signaling System

3.02 The MF signaling method uses six frequencies in the voice frequency band. A combination of two of the six frequencies represents a digit or control code. Ten tone combinations are used for the 10 numeric digits (0-9), one combination for the (ST) signal and another for the (KP) signal. The three remaining tone combinations are used to provide other special signals (control codes).

3.03 On intertoll circuits, MF signaling is used to transmit the address information and SF signaling provides the circuit supervision signals. For most MF systems, the outpulsing rate is between 58 and 75 milliseconds for the pulse and interdigital intervals, or about 7 to 10 digits per second. MF signals are usually transmitted at a -6 or -7 dBm level below the circuit voice level. Table C shows the digits and frequencies along with the control function performed by the special codes. The 966A MAIN DISPLAY appearance is also shown.

TABLE C

MF SIGNALING SYSTEM

DIGIT OR CODE	MF FREQ IN Hz	DISPLAY APPEARANCE
1	700 + 900	1
2	700 + 1100	2
3	900 + 1100	3
4	700 + 1300	4
5	900 + 1300	5
6	1100 + 1300	6
7	700 + 1500	7
8	900 + 1500	8
9	1100 + 1500	9
0	1300 + 1500	0
KP	1100 + 1700	[
ST	1500 + 1700	]
STP	900 + 1700	-
ST2P	1300 + 1700	-
ST3P	700 + 1700	≡

KP = Preparatory for digits
ST = End of pulsing
STP, ST2P, ST3P = Control codes

C. DTMF Signaling System

3.04 The DTMF (Option 03) signaling system was developed to provide a means for push-button signaling from subscriber telephones using the voice transmission path. Two groups of voice frequency tones are used to provide 16 different signals. The signal frequencies are geometrically spaced and no two frequencies of any signal combination are harmonically related.

3.05 Each of the 16 signals available consist of one tone from a HIGH group and one tone from a LOW group. Each group is made up of four tones. The normal phone is only capable of producing 12 of these signals. They are the digits 0 through 9 along with the * and #. The signals A, B, C, and D are used for special services provided to the U.S. Government. Table D shows the digits, tone frequencies, and MAIN DISPLAY appearance on the 966A.

TABLE D

DTMF SIGNALING SYSTEM

DIGIT OR CODE	DTMF FREQ IN Hz	DISPLAY APPEARANCE
1	697 + 1209	1
2	697 + 1336	2
3	697 + 1477	3
4	770 + 1209	4
5	770 + 1336	5
6	770 + 1447	6
7	852 + 1209	7
8	852 + 1336	8
9	852 + 1477	9
0	941 + 1336	0
*	941 + 1209	R
#	941 + 1477	P
A	697 + 1633	a
B	770 + 1633	b
C	852 + 1633	c
D	941 + 1633	d

* # A B C D are special purpose codes

D. DP Signaling System

3.06 A rotary dial transmits digital information by opening and closing the circuit, which is really a sequence of ON-HOOK/OFF-HOOK signals. The numerical digit dialed is determined by the number of ON-HOOK intervals in the train of pulses. Pulses are usually generated at a rate of 10 per second with a 58 to 64 percent break ratio.

3.07 Dial Pulse (DP) signaling is used to transmit address digits (called numbers) from a customer's dial to the serving central office. It is also used to transmit address digits from one central office to another over telephone trunks.

3.08 Dial Pulse signaling is accomplished by making and breaking a DC series "loop" circuit. The cam-operated contacts of a rotary dial perform this function for subscriber-loop signaling. Relay contacts in the outgoing trunk circuit perform the same function for interoffice trunk signaling.

3.09 For Dial Pulse signaling, the make interval is the OFF-HOOK period and the break interval is the ON-HOOK period. The break or ON-HOOK intervals are the dial pulses. A train of pulses with four ON-HOOK intervals represents the digit 4, as an example. Dial Pulse signaling is ordinarily thought of a -48V batter and ground signaling.

3.10 For digital carrier systems, Dial Pulse signaling is accomplished by means of the A and B signaling bits.

3.11 For D1D, D2, D3, and D4 type channel banks, each of the 24 channels provides an A and B signaling path to the distant terminal. It is convenient to think of each channel as containing two built-in SF signaling units, an A and a B.

3.12 Signaling is accomplished by using the 8th bit of each channel's 8-bit word. This is only done, however, every 6th frame.

3.13 A frame consists of an 8-bit word from each of the 24 channels (192 bits) plus a framing bit or 193 bits total.

3.14 The first five frames use 8-bit words for each channel's voice encoding. In the 6th frame, only 7-bit words are used for each channel's voice encoding. The 8th bit is used for signaling.

3.15 For ON-HOOK condition, the 8th bit may be a 1. For an OFF-HOOK condition, the 8th bit may be a 0. One or zero may be used for either condition depending of the type of channel unit.

3.16 The A path signaling information is sent in the 6th frame (A bit). The B path signaling information is sent in the 12th frame (B bit). The process is then continued with A/B path signaling information spaced 12 frames apart.

E. Verification Tests

3.17 The purpose of the verification test procedure is to verify that the Model 966A Trunk Signaling Analyzer is in good working condition prior to any circuit tests.

3.18 120V AC power is required for operation of the 966A. A standard AC line cord is provided with the set and it requires a three-wire grounded type electrical outlet .

DANGER: Do not defeat the third-wire ground by using a three- to two-wire adapter as this could result in an electrical shock.

3.19 Perform the following verification procedure steps in the order given.

1. Connect 120V AC power to the 966A.

2. Turn the POWER switch to the ON position. Three things should occur:

   (a) The MAIN DISPLAY should show flashing 8s. This indicates the microprocessor systems are in "self-diagnostic" routines and are testing themselves for proper operation. This should take about five seconds, after which a three-digit number should appear in the center of the display for about 2 seconds. This indicates that the 966A is able to test FEATURE GROUP "D" EQUAL ACCESS TRUNKS. If these tests are all successful, the display should show a "lazy-T" (it looks like a T laying on its side). If anything else appears on the MAIN DISPLAY, the set should not be used for testing until repaired.

(b) The test set will perform a check of the six LED indicators on each side of the MAIN DISPLAY. The six LEDs should remain illuminated at each end of the MAIN DISPLAY during the "self-diagnosis". If not, the set should not be used until repaired.

(c) The test set will set itself up in the most commonly used mode of operation. An LED indicator should be illuminated to indicate the following selections:

Pulse limit test -- OFF
Trunk type -- LOOP NORMAL
Function -- MONITOR
Display -- BOTH
Mode -- NORM
Reset -- AUTO

F. Circuit Testing

General

3.20 Circuit access for testing is easiest wherever test jacks are available. Some of the locations having jack access are:

Outgoing Trunk Test Frame (OGT)
Testboards
Switch Boards
Central Office Equipment
Two-, four-, or six-wire bays
DSX Bays

3.21 Most test jacks of the type listed above are normalled through and the circuit will be opened when the jack is plugged in. A monitor jack is bridged across the circuit and in some cases, isolating resistors are also provided. Service on the circuit will not be interrupted when a monitor jack is used for test access.

3.22 The detailed test procedures are used for DTMF (Option 03) or DP signaling systems. A block diagram is shown in each procedure. Step-by-step instructions are also included.

3.23 Testing with the Model 966A Trunk Signaling Analyzer generally falls into two categories:

1. MONITOR: In this mode, the 966A receives and displays MF, DTMF (Option 03) and DP signaling while displaying the Originating and Terminating office supervision. High impedance bridging is used so as not to interfere with the trunk.

2. SIMULATE: In this mode, the 966A acts as a Terminating office and provides battery and supervision just as a real Terminating office would. Several types of Terminating offices may be simulated, including WINK-START, DELAY DIAL, and BYLINK (IMMEDIATE DIAL).

3.24 Three sets of parallel jacks are provided to connect the 966A to the circuit under test. Connect Tip--Ring, Tip 1--Ring 1 and E&M as required by the trunk to be tested. Loop supervision trunks will require only a Tip--Ring connection. Two-wire E&M trunks require Ring--Tip and E&M connection. Four-wire E&M trunks require Tip--Ring, Tip 1--Ring 1 and E&M.

3.25 Connection procedure will depend on the trunk access available and whether the MONITOR or SIMULATE function is desired. The following text suggests commonly used access methods.

Monitor Function Connections

3.26 Six-wire jacks provide access to either the LINE or DROP of a trunk. Normal cut through contacts provide connection through the jack field. Two single cords or one dial cord should be used for each connection required. Connection should be from LINE to the 966A and from the 966A to DROP. In this way, the trunk under test is looped through the parallel connected 966A jacks. The trunk is not interrupted and operates in the normal manner. Depending on trunk type, the number of cords required will vary. A four-wire E&M trunk for example will require six single cords or three dual cords.

3.27 Monitor jacks provide parallel access to the trunk under test. Jack connection does not cause the trunk to be opened. One single cord should be used for each connection required. The cord can be connected to either of the two parallel jacks on the 966A. Depending on the trunk type, the number of cords required will vary. A four-wire E&M trunk may require three cords for connection.

3.28 Trunk connection at the MDF can be done by using split cords or the appropriate connecting shoe. Tip--Ring, Tip 1--Ring 1 and E&M should be connected as required. Remember that the E Lead is on the E&M jack tip and the M Lead is on the ring.

Simulate Function Connections

3.29 Since six-wire jacks provide access to either the trunk LINE or DROP, they are convenient for use with SIMULATE functions. Remember that in SIMULATE, the 966A takes the place of the Terminating office. Thus the real Terminating office must be disconnected from the trunk under test and the 966A connected in its place. If testing is being done at the Originating office, the 966A should be connected to the Trunk DROP. A single cord is used for each connection required. For testing in the Terminating office, the 966A is connected to the Trunk LINE. Again, a single cord is used for each connection required.

3.30 If six-wire jacks are not available, other access points can be used with SIMULATE Functions. The trunk under test must be opened to disconnect the real Terminating office. This can be done at the MDF by removing the connecting jumpers or pulling the heat coils. In the Originating office, carrier trunks may be opened by removing the appropriate channel unit. Once the trunk to be tested is opened, connection at Monitor Jacks of the MDF is done as previously described.

Setup Procedures

3.31 Five groups of control keys were set automatically at power up, for the most common type of test and trunk. Determine if any of the control key selections are incorrect for the type of test or trunk and make corrections as necessary. The control key groups are:

1. Trunk type: LOOP NORMAL, LOOP REVERSE, E&M ORIGINATING E&M TERMINATING. Select the appropriate control key for the type of trunk to be tested.

2. Function: MONITOR, SIMULATE WINK, SIMULATE DELAY DIAL, SIMULATE BYLINK (IMMEDIATE DIAL). Select the appropriate function, MONITOR or SIMULATE, as desired. For SIMULATE functions, the 966A takes the place of the Terminating office.

3. Display: REC 1, REC 2, BOTH. Determine the number of records that will be received per call. REC 1 is selected if only one record is to be received per call (Called Number). REC 2 or BOTH is selected if two records are received per call as in TSPS or ANI. (Called Number plus Calling Number). BOTH and FEATURE 4 are selected if three records are to be received per call as for Automatically Billed Calls (ABC). The third record is the credit card number.

4. Mode: NORM IDDD. NORM is selected unless testing an International Direct Distance Dialing trunk (IDDD).

5. Reset: AUTO, HOLD, MANUAL. AUTO resets the display each time a new record is received. HOLD will hold a record received on the display until the MANUAL key is pressed. The MANUAL key clears the display.

3.32 Determine if any special FEATURE is required. If a special FEATURE is required, put the test set in the FEATURE selection mode and select the appropriate FEATURE. After selection of the FEATURE, return the set to the digit-reception mode.

G. Feature Selection

3.33 The 966A has a special FEATURE select mode allowing the operator to select one or more of five special FEATURES to aid in trouble analysis. The five FEATURES are:

FEATURE 1: MISSING KP/ST DETECT

Detects and holds MF signaling records which do not begin with KP and end with ST, STP, ST2P or ST3P. This FEATURE, when selected, disables DTMF (Option 03) reception.

FEATURE 2: NO KP REQUIRED

Accepts MF signaling without the normally required KP signal at the beginning of the record. This feature, when selected, disables DTMF (Option 03) reception.

FEATURE 3: NO ANSWER SUPERVISION DETECT

Detects and holds signaling records when the Originating office remains OFF-HOOK for over two minutes without the Terminating office ever going OFF-HOOK.

FEATURE 4: DTMF RECEPTION

Enables the test set to display and analyze TOUCH-TONE* (DTMF) pulsing. MF and DP receive capabilities are included as standard features.

FEATURE 5: AUTOMATICALLY BILLED CALLS (ABC) DISPLAY

Records and displays the three-record signaling format used in Automatically Billed Calls. The first two records are MF for the Called and Calling number. The third record is DTMF (Option 03) for the credit card number.

FEATURE GROUP D EQUAL ACCESS FEATURES

FEATURE 6: EQUAL ACCESS ONE RECORD CALL

Records and displays one record pulsing format calls. As used by the FEATURE GROUP D EQUAL ACCESS protocol.

FEATURE 7: EQUAL ACCESS TWO RECORD CALL

Records and displays two record pulsing format calls. As used by the FEATURE GROUP D EQUAL ACCESS protocol.

FEATURE 8: EQUAL ACCESS THREE RECORD CALLS

Records and displays three record pulsing format calls. As used by the FEATURE GROUP D EQUAL ACCESS protocol.

(Note: These call records differ from FEATURE 4 in that all three records are in MF pulsing).

FEATURE 9: WINK BACK AFTER RECORD ONE

Provides wink back after record one, including proper time delay, as described by FEATURE GROUP D EQUAL ACCESS protocol. (Not affected by FEATURE 10 or 11).

FEATURE 10: WINK BACK AFTER RECORD TWO

Provides wink back after record two, including proper time delay, as described by FEATURE GROUP D EQUAL ACCESS protocol. (Not affected by FEATURE 9 or 11).

FEATURE 11: WINK BACK AFTER RECORD THREE

Provides wink back after record three, including proper time delay, as described by FEATURE GROUP D EQUAL ACCESS protocol. (Not affected by FEATURE 9 or 10).

3.34 The following procedures are used to select the special FEATURES on the 966A Trunk Signaling Analyzer. If you are selecting FEATURES 1 through 5, use procedure A. If you are selecting FEATURES 6 through 11 for FEATURE GROUP D FOR EQUAL ACCESS, use procedure B.

A. FEATURE SELECT FOR NORMAL TRUNK TESTING

1. Momentarily operate the OFF key in the Pulse Limit Test key group.

Notice it also has the letter "F" (for FEATURE) on the key itself. The red LED near OFF should illuminate. If the LED is already illuminated, this step is unnecessary.

2. Momentarily operate the OFF key again. The OFF key indicator should begin blinking, indicating the FEATURE select is ready.

3. All LEDs under Trunk Type Function and Display should be illuminated. If the LED associated with key 3 is not illuminated, it indicates the 966A is not equipped with NO ANSWER SUPERVISION DETECT. If FEATURE GROUP D FOR EQUAL ACCESS software is incorporated and the LED associated with key 4 is not illuminated, it indicates the 966A is not equipped with DTMF (Option 03).

4. Notice that the keys under Trunk Type Function and Display have numbers on them from one to eleven. These numbers represent the eleven FEATURES.

5. For each FEATURE desired, momentarily operate the appropriate numbered key in the Trunk Type key group. The associated LED should also begin flashing, to indicate the selection is in effect. In case of error, the FEATURE just selected may be cleared by operating the key again.

6. After selection of the FEATURE(s) desired, return the set to the digit-reception mode by pressing the "F" key.

7. Some FEATURES may not be accessible if other associated features are not selected. For example, DTMF reception - Option 03 (key 4) and Third Record (key 5). For ABC calling, FEATURE 4 must be activated before FEATURE 5 can be activated. Some FEATURES are mutually exclusive. For example, when FEATURE 1, MISSING KP/ST detect is selected, FEATURE 2, NO KP REQUIRED, FEATURE 4, DTMF (Option 03) and FEATURE 5, AUTOMATICALLY BILLED CALL display (ABC) are disconnected and the associated LED indicators are dark.

B. FEATURE SELECT FOR FEATURE GROUP D TESTING

1. Momentarily operate the SIMULATE WINK key (6) and see that the associated LED illuminated. The Originating and Terminating LEDs should also illuminate.

2. Depress the "F" key and see that its associated LED blinks continuously and all Trunk Type and Function LEDs are illuminated. (If not, press "F" again).

3. You must now select the appropriate numbered keys (6 through 11) to match the protocol of the call type being tested. (That is, are you receiving one, two, or three records per call and do you respond with a wink after each or any, etc.)

4. The associated LEDs for key 6, 7, or 8 will blink after they have been selected. The associated keys, 9, 10, and 11, can only be selected to match the number of records required by FEATURES 6, 7, and 8. For example: If there will be only one record, select key 6. Then key 9 (wink back after one record) can be selected. Keys 10 and 11 will not be initialized if pressed, and the associated LEDs will not blink. If FEATURE 7 EQUAL ACCESS calls having two records is selected, key 9 (wink back after one record) and key 10 (wink back after two records) can be selected as needed. The associated LED indicators will blink, indicating selection. If FEATURE 8, EQUAL ACCESS calls having three records is selected, keys 9, 10 and 11 (wink back after three records) can be selected.

5. Press the "F" key to return the 966A to normal receive mode. The FEATURE Trunk Type and Function LEDs will go dark. Only the LEDs

associated with keys selected before entering the FEATURE mode will be illuminated, and not blinking. The 966A is now ready to receive the EQUAL ACCESS records.

H. Pulse Limit Test

3.35 The Pulse Limit test is left in the OFF condition by the power up "self-diagnostics" routine. To use the Pulse Limit Test, it is not necessary to set the testing parameters for pulse width and pulse amplitude. The limits are automatically set to 30 milliseconds for pulse width and to -24 dBm for pulse amplitude. To enter other parameters, do the following:

1. Momentarily depress the READ key. The MAIN DISPLAY will show 30 over the MS legend and -24 over the DBM legend. These initial settings are established by the built-in program each time the 966A is powered up. Shown below is an example of using the READ command to view the Pulse Limit Test initial settings.

2. Determine the desired pulse width in milliseconds and pulse amplitude level in dBm from the circuit layout record or equivalent document. If information is not available, use 70 milliseconds for pulse width and 3 dB below the voice level (TLP), at the circuit access point, for the pulse amplitude level.

3. Set the desired pulse width in milliseconds with the SET MS key. Each time the key is pressed, the number of milliseconds shown will advance by 5. After reaching 120 ms, the next operation of the key recycles the number of ms back to 30. The range is 30 to 120.

4. Set the desired pulse amplitude in dBm with the SET DBM key. Each time the key is pressed, the number of dBm shown will advance by 2. After reaching +4 dBm, the next operation of the key recycles the number of dBm back to -24 dBm. The range of dBm is -24 dBm to +4 dBm.

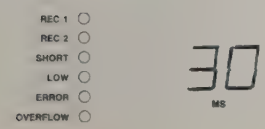
5. Once the pulse width and amplitude limits are set, the Pulse Limit Test is activated by pressing the TEST KEY.

3.36 Any MF or DTMF (Option 03) pulses which fail to meet the operator-set width and amplitude limits cause the SHORT and /or LOW indicators to illuminate as appropriate, and the 966A to jump from AUTO Reset to HOLD. This feature is useful for trapping intermittent pulsing failures.

3.37 When pulses fail to meet these limits, the SHORT and/or LOW LED indicators, located to the left of the MAIN DISPLAY, are illuminated as appropriate. By using the EXAMINE ERROR key, the operator can tell which pulses failed which limits.

3.38 Because the 966A actually measures and stores the length and amplitude of each MF and DTMF (Option 03) pulse received, it is possible to determine the values for individual pulses after the record has been captured. This is done by changing the length and amplitude limits and noting which pulses pass and which pulses fail. For example, if a particular MF digit causes a low amplitude error (LOW LED illuminated) when the pulse amplitude limit is set to -6dBm, but it passes at -8 dBm (LOW LED extinguished), then the amplitude of that pulse is in the range of -8 to -6 dBm.

3.39 Any MF of DTMF (Option 03) pulses that do not meet the pulse limits that were set will cause the LOW and/or SHORT LED indicators to be illuminated. If both low and short tones are received, both LEDs will be illuminated.



3.40 Shown below is a sample display of an MF pulsing record received. This sample would be similar for analyzing DTMF (Option 03) records. At the beginning of the display is the symbol for KP followed by the ten-digit number outpulsed and ending with the symbol for ST. Both the LOW and SHORT LED indicators are illuminated to indicate that a Pulse Limit Test failure has occurred.

3.41 To determine the exact nature of the failure, press and hold the EXAMINE ERROR key. In this example, if digits 3 and 6 have not met the limits set, failed digits will flash for 5 seconds each.

3.42 The third digit flashes and the LOW and SHORT indicators are illuminated to indicate this digit was both low and short. Next, the sixth digit flashes and again, the indicators are illuminated to show that the digit was both low and short. (The EXAMINE ERROR) key must remain depressed while examining the display).

I. Simulating a Terminating Office

3.43 The Model 966A Trunk Signaling Analyzer can act like a Terminating office for testing. It is necessary to make sure that the normal Terminating office is not connected to the trunk during these tests.

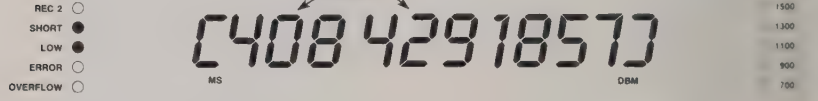
3.44 If the testing is taking place at the Originating office, the 966A must be connected to the DROP side of the circuit. When testing in the Terminating office, the 966A must be connected to the LINE side of the circuit.

3.45 The 966A provides answering supervision as required to satisfy the various trunk types and FEATURE GROUP D EQUAL ACCESS protocol. It also provides a 1004 Hz call completion tone after answer. The four functions are:

1. SIMULATE WINK: When selected, the 966A Simulates a WINK start Terminating office, i.e. 200 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK of 150 ms (WINK). At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by the Trunk Type key group.

2. SIMULATE DELAY DIAL: When selected, the 966A simulates a DELAY DIAL start Terminating office, i.e., within 80 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK (Delay Dialing Signal) of 100 ms. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call completion tone. Appropriate E&M signals are provided as selected by the Trunk Type key group.

3. SIMULATE BYLINK: When selected, the 966A simulates a BYLINK (IMMEDIATE DIAL) Terminating office, i.e., Terminating office supervision remains ON-HOOK until outpulsing is completed. If no outpulsing is detected within 4 seconds, the 966A will go OFF-HOOK and switch



to REC 2 and wait for outpulsing. "F" will appear in REC 1. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by Trunk Type Key group.

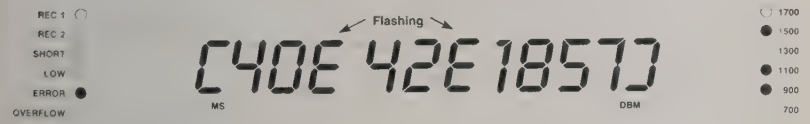
4. SIMULATE FEATURE GROUP D FOR EQUAL ACCESS: When selected, the 966A simulates a receiving office for FEATURE GROUP D protocol signaling. MF signaling is used to transmit numerical information and standard ON-HOOK/OFF-HOOK is used for the WINK. Appropriate WINK signals and time delays are provided as have been selected by FEATURES 6 through 11 to satisfy the sending entity. After the last record is received (as selected above) and the last wink-back has been sent, the 966A provides an OFF-HOOK answer signal and 200 milliseconds later it sends a 1004 Hz call-completion tone.

3.46 Figure 3 shows a block diagram of a typical test setup using the SIMULATE function. The procedure is to start in the Originating office and progress toward the Terminating office. Starting at Location 1, the 966A is used to check the Originating switching machine and outgoing trunk equipment. Any problems caused by Carrier or the Terminating office are removed. If everything checks out, the testing progresses along the trunk. At Location 2, testing checks carrier as well as the Originating office. If everything checks out here, the problem is most likely in the Terminating switching machine.

3.47 PABX trunks are the source of many maintenance problems, particularly if a non-telephone company PABX is used. The 966A SIMULATE Function is a quick way to check PABX. The MONITOR mode can also be used to check the pulsing and supervision being received or sent by the PABX switch.

J. Mutilated MF Digits

3.48 Shown below is a sample display of an MF pulsing record with two mutilated digits



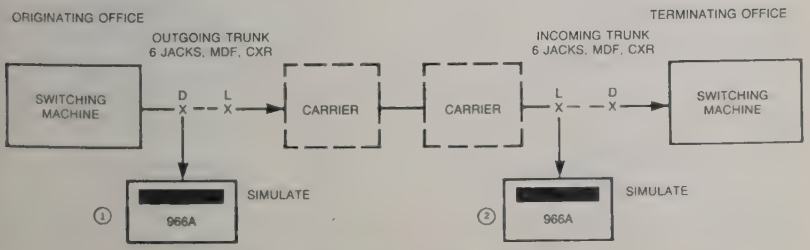


Figure 3. Simulating a Terminating Office

(digits with only one or more than two MF tones). Mutilated digits are represented by a flashing "E".

3.49 To determine the exact nature of the pulsing error, the operator presses and holds the EXAMINE ERROR key. The tones actually received for a mutilated digit are displayed to the right of the MAIN DISPLAY by the appropriate tone indicators.

K. Missing or Mutilated KP Pulses

3.50 The 966A normally requires a KP pulse (KP2 in IDDD mode) to enable the MF receiver. Without first receiving a KP of (KP2 in IDDD), the test set will not receive or display subsequent MF pulsing. This type of operation is identical to that provided by the standard central office MF receivers. The reason for this in both the 966A and in central office receivers is to reduce the possibility of voice simulation of MF digits by inhibiting operation until a KP pulse is detected.

3.51 In certain trouble situations, the required reception of a KP pulse before any further MF pulsing is received and displayed may not be desirable. This is particularly true if the pulsing problem involves a mutilated or missing KP pulse. To aid in analyzing such troubles, it is possible to disable the KP start requirement in the 966A. This is done by selecting FEATURE 1 or FEATURE 2. FEATURE 1 also automatically detects missing ST codes.

3.52 When the test set is first turned on, it operates in the standard manner in which a KP (or KP2 in IDDD Mode) is required to initiate recording and display of MF pulsing. To disable the requirement for a starting KP pulse, select FEATURE 1, MISSING KP/ST DETECT or FEATURE 2, NO KP REQUIRED. The test set will now display MF pulsed without a starting KP. If the KP is mutilated, it will be displayed in the normal manner as a flashing "E".

3.53 To restore standard operation, disable the selected FEATURE. The test set will go back to standard operation. It is suggested that FEATURE 1 or 2 should only be used in situations where required. This is because the possibility of MF digit voice simulation is greater without the protection of KP enable.

L. DTMF and DP Operation

3.54 The 966A will display DTMF (Option 03) and DP pulsing on the MAIN DISPLAY in much the same way as MF pulsing. The 966A continuously looks for MF, DTMF and DP pulsing. Select FEATURE 4 to enable DTMF reception. This feature is particularly useful for multiple-stage pulsing employing several different types of pulsing. Such pulsing is found in CAMA, ANI, CCC and certain TSPS applications.

3.55 For DTMF (Option 03) operation, the 966A employs a 5-second time-out feature to indicate end of pulsing. When in the MONITOR or SIMULATE mode, a 5-second interval between pulsing will cause the test set to start a new record when additional pulses are received.

3.56 For DP operation, the 966A requires proper trunk supervision input. Therefore, Trunk Type selection must be correct. Trunks employing either LOOP or E&M supervision may be tested.

3.57 DP may be received in either MONITOR or SIMULATE Functions. In MONITOR, the number of DP digits outpulsed can vary. The 966A continues to store digits in a record until an ON-HOOK is detected indicating the end of the call being monitored.

3.58 The situation in SIMULATE Functions is different because the 966A must detect the end of outpulsing and send answer supervision and call-completion tone. For DP operaton, the set does this by counting digits. Seven digits is assumed to be a call if the second digit is not a "0" or 1. At the end of the seventh digit, the 966A supplies the OFF-HOOK supervision and 1004 Hz call-completion tone as required to simulate the Terminating office. If the second digit is a 0 or 1, the 966A assumes that a ten-digit call is being outpulsed. At the end of the tenth digit, the 966A responds with OFF-HOOK supervision and 1004 Hz call-completion tone as appropriate.

3.59 For calls 1 to 6 digits long, the 966A detects the end of pulsing by time-out. This is done by assuming that if 5 seconds elapse without a new digit being dialed, that pulsing is

complete. Time-out is also used to determine the end of pulsing for seven-digit calls with 0 or 1 in the second digit.

M. DS-1 PCM RECEIVER Operation

3.60 The DS-1 PCM RECEIVER (Option 04), when provided, enables the operator to access and decode a DS-1 (1.544 MBPS) bit stream on a monitor basis. The DS-1 bit stream contains both signaling and voice frequency information for each of the 24 channels present. Any channel from 1 to 24 may be selected for decoding.

3.61 Each of the 24 channel units contains a type of built-in signaling, i.e., the A BIT and B BIT signaling system. This is the system normally used for signaling over PCM carrier trunks. However, certain types of trunks may also use MF or DTMF (Option 03) signaling in addition to the built-in signaling. The built-in signaling may be used for supervision and MF or DTMF (Option 03) signaling may be used for address signaling.

3.62 Power, voice frequency and A/B BIT signaling information is transferred between the 966A and the DS-1 PCM RECEIVER by means of the conductor RIBBON CABLE.

3.63 After AC power has been connected to the 966A and the power switch operated to the ON position, perform the following steps in the order given:

1. Trunk Type: Select either E&M Originating for TR, DS1 inputs or E&M Terminating for T1R1, DS1 inputs.

2. Function: Select MONITOR. The SIMULATE function cannot be used in conjunction with the DS-1 PCM RECEIVER.

3. Display: Select REC 1, REC 2 or BOTH and FEATURE 6, 7, or 8 for the number of display records expected (one, two, or three).

4. Mode: Select NORM or IDDD for the desired type of trunk to be tested.

5. Reset: Select the appropriate reset mode, AUTO or HOLD, as desired.

3.64 The 966A will now display MF, DTMF (Option 03) tone pulsing. Originating or Terminating office supervision will also be displayed depending upon switch selection.

3.65 All types of signaling errors such as SHORT or LOW MF or DTMF (Option 03) tone pulses, mutilated MF digits and missing KP and ST codes can be detected and analyzed. The unique Pulse Limit Test feature can also be used as required. See Part H for more details on detection of pulsing errors and operation of the Pulse Limit Test Feature.

3.66 After power has been connected to the 966A and the POWER switch operated, the POWER ON indicator on the DS-1 PCM RECEIVER will illuminate.

3.67 Listed below are the seven different controls for the DS-1 PCM RECEIVER (Option 04). Perform the following steps in the order given.

1. D1D, D2, D3, and D4 SWITCH: Select the appropriate position for the type of channel sequence/bank under test.

2. CCIS/NORM SWITCH: Select NORM to decode A/B BIT signaling every 6th frame. Select CCIS to decode the channel as all voice frequency information with no signaling.

3. A BIT/B BIT SWITCH: Select the appropriate position to determine which bit is to be used for the E&M output.

4. PCM/VF SWITCH: Select either digital or voice frequency operation for both the 966A and the DS-1 PCM RECEIVER.

5. CHANNEL SELECT: Select the channel to be tested (1-24).

6. TERM/BRIDGE SWITCH: Select the appropriate position for the input impedance required.

7. TR/T1R1 SWITCH: Select the TR position to test the outgoing side of

the span line or the T1R1 position to test the incoming side.

3.68 Two sets of parallel jacks are provided to connect the DS-1 PCM RECEIVER (OPTION 04) to the PCM system to be tested. Connect the TR jack to the outgoing side of the span line and the T1R1 jack to the incoming side of the span line. One connection may be made if only one side of the span line is to be tested. The NO PCM lamp will extinguish to indicate proper connection to a live PCM line.

3.69 Figure 4 shows the 966A being used in the MONITOR mode at the DSX-1 bay. The central offices have digital-type switches. Pulsing and supervision on in-service trunks are easily observed and checked for errors using the MONITOR Function. Even difficult, intermittent errors are easy to catch using the 966A's automatic error-trapping feature. Trunks can be monitored in either the Originating or Terminating office to determine the source of signaling problems.

3.70 MONITOR functions can also be used to check and routine other central office equipment including senders and MF and DTMF coin circuits. MONITOR is used with FEATURE 3, NO ANSWER SUPERVISION DETECT, to detect trunks with answer supervision problems caused by fraud or equipment failure.

N. DROP & INSERT Operation

3.71 When using the DROP & INSERT with the 966A Trunk Signaling Analyzer, certain steps must be taken to insure proper operation of both units. To set up the 966A for operation with the DROP & INSERT, perform the following steps in the order given:

1. Select E&M Terminating for Trunk Type. (All T1 channel access made with the 966A use this Function setting.)
2. Select type of simulation; MONITOR for no wink activity, SIMULATE WINK, SIMULATE DELAY DIAL or SIMULATE BYLINK.
3. Select number of records to be received; REC 1, REC 2, or BOTH. If testing FEATURE GROUP D FOR EQUAL ACCESS, select Features. See section G.
4. Select either NORMAL or IDDD Trunk Type.
5. Determine where the DROP & INSERT unit is to be patched into the span line. A typical location is at the DSX (Digital Cross Connect) frame.

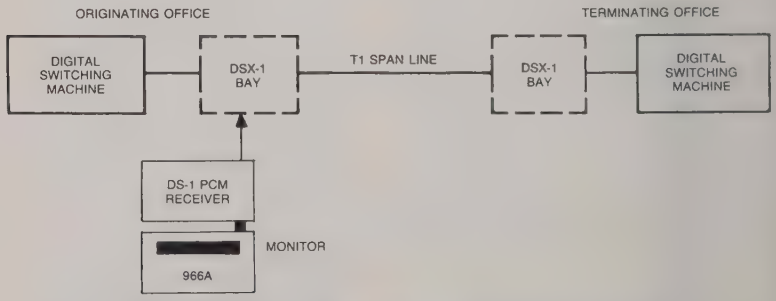


Figure 4. Digital Trunk Testing with DS-1 PCM Receiver (Option 04)

6. Patch from the DSX "Monitor" jack to the Option 05 "PCM IN" jack.

7. Check that no alarm indicators on the DROP & INSERT front panel are illuminated. An illuminated alarm LED indicates trouble on the span.

   Note: Perform the following steps as quickly as possible to reduce possible disturbance to the T1 carrier under test:

8. Patch from the "PCM OUT" jack on the Option 05 to the "Send" jack on the DSX.

   Note: If steps 6, 7 & 8 are not followed exactly, traffic will be affected (interrupted).

3.72 To MONITOR a selected channel with the DROP & INSERT, perform the following steps in the order given:

1. Set the PCM IN switch to the BRIDGE position.

2. Set the TEST SET INTERNAL/ EXTERNAL switch to the INTERNAL position to connect the 966A to the DROP & INSERT unit.

3. Set the MODE switch to the MONITOR position.

4. Set the FORMAT switch to select the appropriate digital format, D1D, D2, D3, or D4.

5. Select the desired channel using the channel select thumbwheel switches.

6. Channel supervision may now be monitored through either the A/B BIT indicators located on the front panel of the DROP & INSERT unit or by use of the supervision LEDs located on the front panel of the 966A test set.

3.73 Decoded voice frequency and signaling will be passed to the 966A's display and speaker.

Note: No connection may be made to the front panel jacks on the 966A. Doing so would "double terminate" the 966A and allow for erroneous signal levels.

3.74 To operate in the DROP & INSERT mode, configure the 966A test set and the DROP & INSERT unit as described above. Then select DROP & INSERT mode with the MODE switch. This will allow the 966A to receive supervision and voice frequency signals from the selected PCM channel and allow the 966A to Insert supervision and voice frequency signals back onto the selected PCM channel.

Note: In the DROP & INSERT mode, the 966A will function as if it were connected to an analog line. As records are received, winks are returned and, depending on settings of the 966A, an aswer-back tone will be sent.

3.75 By moving the TEST SET INTERNAL/ EXTERNAL switch to the EXTERNAL position, other types of test equipment may be connected to the DROP & INSERT unit. In EXTERNAL Mode, the TR T1,RI and E&M jacks located on the front panel of the 966A are disconnected from the DROP & INSERT unit.

All supervision and decoded voice frequency signals will now be passed to the equipment connected to the EXTERNAL jacks. This mode is used when operating the 966A with analog trunks.

Note: When the DROP & INSERT is in EXTERNAL mode and a signaling set is plugged into the EXTERNAL DROP & INSERT front panel jacks, the A/B BIT Supervision switches located to the left of the unit must be set to the "0" position to allow the external set to control A/B BIT forward supervision through the M lead. When the E&M jack is vacant, these supervision switches can be used to set supervision.

XMIT MODE OPERATION

Note: XMIT mode operation is used for new installations or out of service span lines. It enables the DROP & INSERT unit to simulate a channel bank. Since it disrupts all 24 channels of the T1 carrier, special care should be excercised when using this mode, to prevent accidental circuit outage.

3.76 Verify that the span line is not in service. Then connect the XMIT jack to the span line to be tested. The A and B BITS can be controlled by the TRANSMIT A/B switches. These switches control the A and B BITS on all 24 channels of the span line.

3.77 The Drop & Insert Unit (Option 05) front panel layout, switches, jacks, and controls are shown in Figure 5. The circled callout numbers in the figure correspond with the circled callout numbers in the following text.

① **BPV-Bipolar Violations,** red when illuminated. Indicates the receipt of two consecutive positive or negative bits.

② **CXR-Carrier Loss (Red Alarm)** indicates the loss of the DS-1 (1.544 MBPS) bit stream input.

③ **FRM-Frame Loss** when illuminated indicates the PCM receiver is out of frame and is in the process of trying to re-frame on the incoming signal, i.e., a misframe condition exists.

④ **RMT-Remote Alarm (Yellow Alarm)** when illuminated indicates a remote alarm condition is being received from the remote office (bit 2 is suppressed on all channels).

⑤ **SB-Signaling Frame Loss,** red when illuminated. Indicates loss of signaling frame.

⑥ **PCM IN-TERM/BRIDGE:** Selects the DS-1 terminating impedance. 100 ohms for the terminating position and 1000 ohms for the bridging position.

⑦ **MODE-Drop & Insert/Monitor:** In the MONITOR position allows monitoring of the selected channel through either the external TR, T1R1, E/M output jacks or through the 966A test

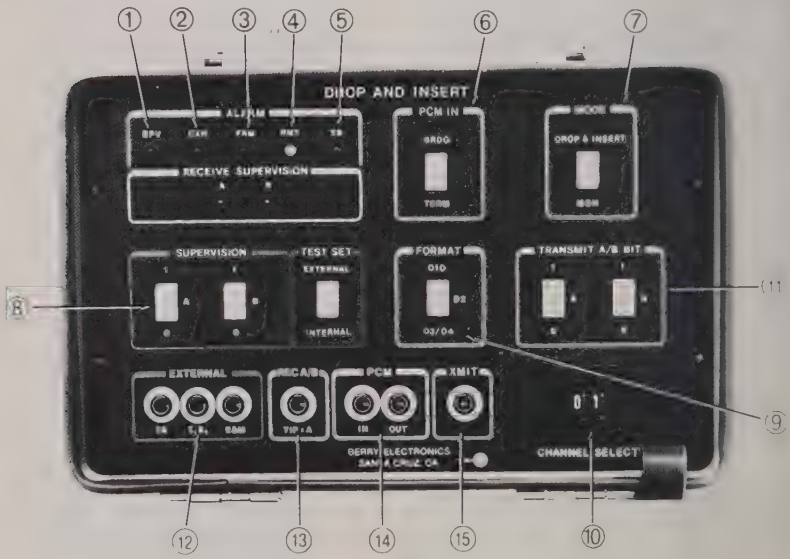


Figure 5. DROP & INSERT Front Panel

set. In the Drop & Insert position, applies test signal to a selected channel as determined by either the input from the external TR, T1R1, E/M jacks or the 966A test set.

⑧ **Supervision-A/B Bit Status and Test Set Internal/External:** TEST SET INTERNAL/EXTERNAL switch selects which set of audio and supervision inputs are directed to the DROP and INSERT UNIT, (external inputs TR, T1R1, E/M are disconected) allowing the 966A, digital send and receive capabilities over the selected DS-1 channel. External, allows the user to connect external test equipment to the DROP and INSERT UNIT through the external TR, T1R1, E/M jacks located on the front panel. (In this mode, the 966A is completely isolated from the DROP and INSERT UNIT).

> Note: Operation of the A/B bit supervision switch is in the External position. There will be NO effect to the send supervision A/B bits of the selected channel when the switch is in the INTERNAL POSITION. The "A" switch is used to control the A send supervision bit, the "B" switch is used to control the B send supervision bit of the selected channel.

⑨ **Format-D1D/D2/D3/D4:** Selects carrier format, either D1D, D2 or D3/D4.

⑩ **Channel Select-1/24:** Selects the channel for the DROP and INSERT UNIT.

⑪ **Transmit A/B Bit-A/B:** A switch controls the send supervision bit of the A bit on all 24 channels from the XMIT jack. B switch controls the send supervision bit of the B bit on all 24 channels from the XMIT jack.

⑫ **External TR, T1R1, E/M:** Allows connection of external text equipment to the DROP and INSERT UNIT. Inputs are transient protected.

⑬ **REC A/B:** Receive supervision bit output. This output is used to connect external supervision monitoring equipment to the DROP and INSERT UNIT. Output connections are; TIP=A bit, RING=B bit, and SLEEVE=Ground. The A/B bit outputs are of the open collector type.

⑭ **PCM IN, PCM OUT:** T1 carrier span line input and output jacks.

⑮ **XMIT:** This jack provides a framed T1 carrier output signal (see XMIT A/B bit supervision switches).

Drop & Insert (DSX)

To access the DS-1 Bit Stream you must first determine which direction of traffic you want to insert on. As shown in Figure 6, use ① the "Monitor" Jack of the appropriate set of jacks and insert into ② PCM IN on the Option 05.

Then jack front ③ PCM OUT to the ④ "IN" jack on the opposite DSX Jack Set .

Note: Perform step 4 quickly. Carefully follow this procedure so as not to interrupt traffic.

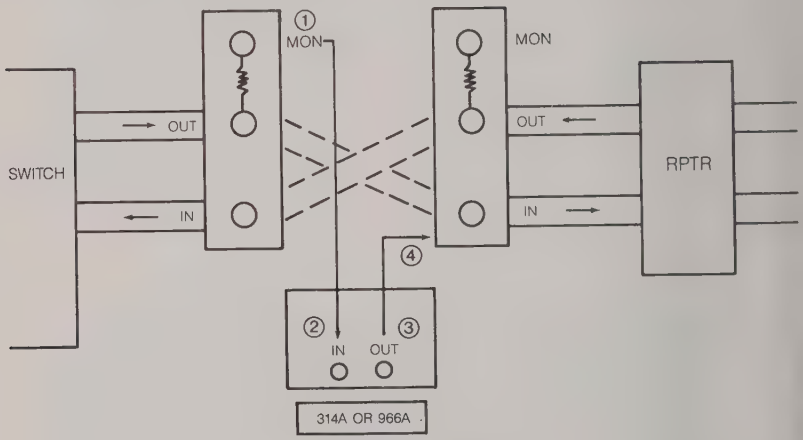


Figure 6. Drop & Insert (DSX)

Channel Bank Testing

Figure 7 illustrates that, by using the analog portion of the 314A and the digital interface on the 966A, you can simulate signaling with the 314A and terminate the digital trunk with the 966A Option 05. When the 966A receives a full set of signals (start and stop), it will automatically insert a (-16 dBm) tone back toward the originating point for calibration purposes.

Trunk Turnup

Figure 8 illustrates that, by using both sets together, trunks can be checked for digital errors first. (This will prove that the trunk and repeaters are operating.) Then you can pass the signaling all the way through to the switch to assure that traffic will pass.

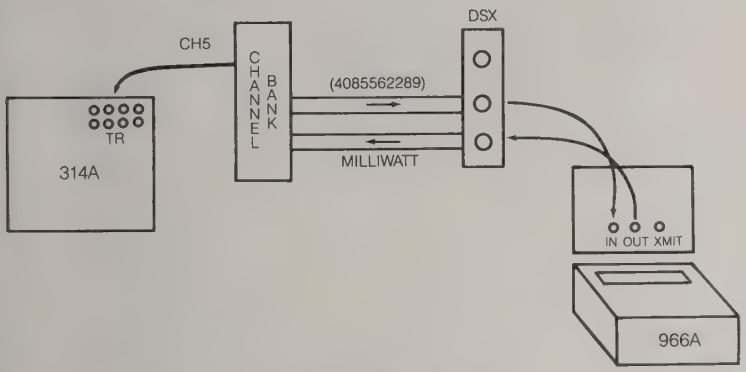


Figure 7. Channel Bank Testing

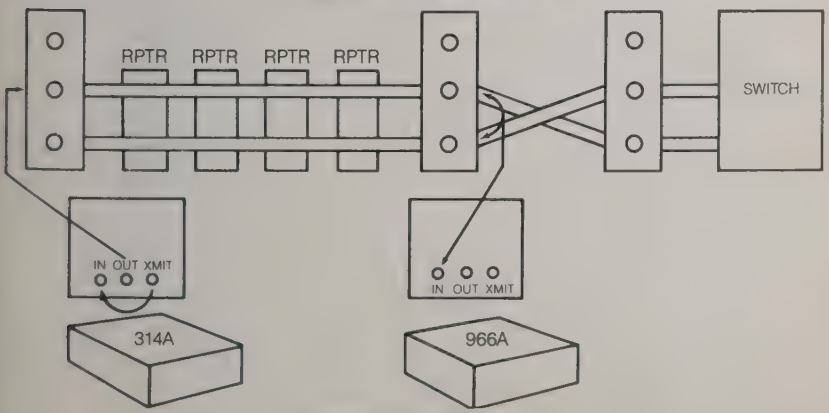


Figure 8. Trunk Turnup

Switch Turnup/Generic Testing

By using the PCM IN and OUT jacks on the Option 05 (as shown in Figure 9), you may originate or terminate traffic into or out of a digital switch under test. You may also use this arrangement to test software generics in your switch.

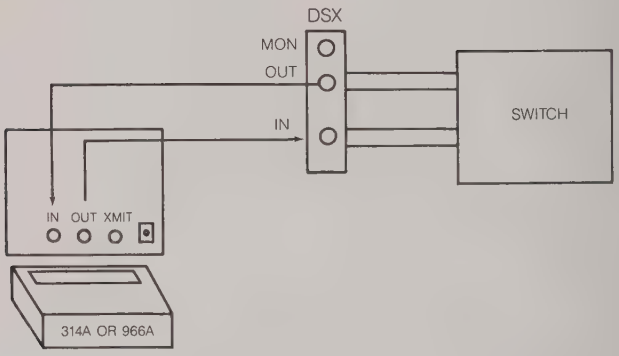


Figure 9. Switch Turnup/Generic Testing

MUX/Trans MUX Framing

Improper framing between bit streams on MUX equipment will cause excessive noise on individual channels. In the past, this process took many pieces of equipment and many engineering hours. Now this task can be easily and quickly taken care of. Proper framing is illustrated in Figure 10. The Option 05 is extremely sensitive to framing errors and will indicate errors until the MUX bay is framed properly.

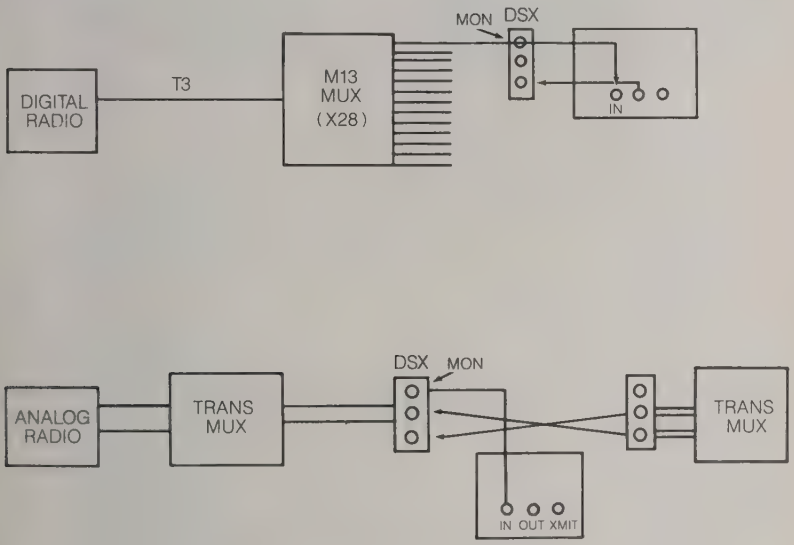


Figure 10. MUX/Trans MUX Framing

Demarcation Turnup

The 966A with Option 05 may be used to perform terminating acceptance test on a T1 high capacity trunk. See Figure 11. By connecting "DSX OUT" to the Option 05 IN, and the Option 05 OUT to "DSX IN," a complete loop is formed. All error indicators should turn off and any particular channel can be terminated by selecting the appropriate trunk channel via the thumbwheel switch and setting the 966A to E&M TERM.

Using External Equipment

External analog equipment may be interfaced onto the bit stream by simply jacking into the TR, T,R, and E&M jacks, as shown in Figure 12. Switch between sets by operating the "INTERNAL/EXTERNAL" switch.

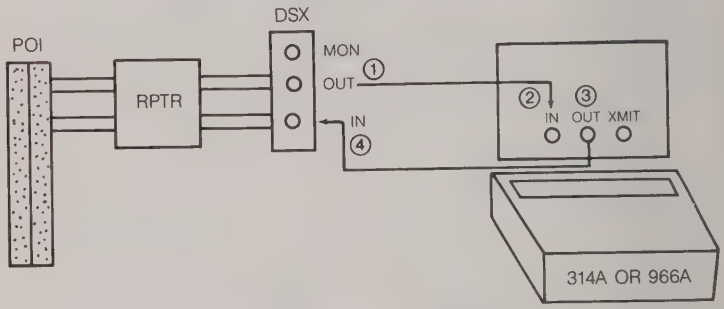


Figure 11. Demarcation Turnup

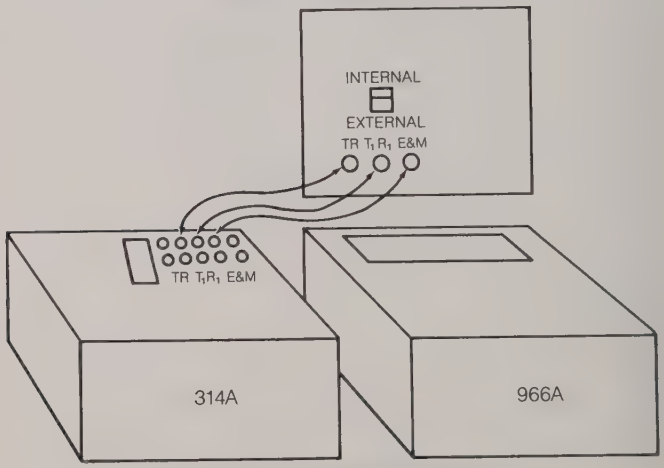


Figure 12. Using External Equipment

O. Test Procedures

3.78 The test procedures which follow are representative examples only. They are not intended to be all inclusive but rather to show, in a general fashion, how testing is accomplished with the 966A. The testing procedures are:

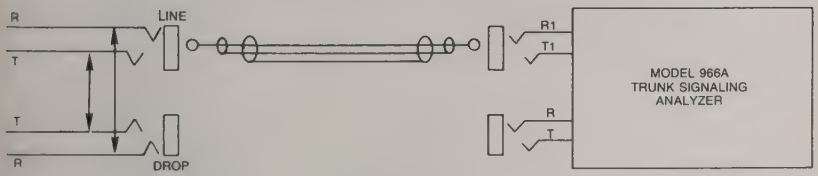
(a) TEST PROCEDURE NO 1 -- MF CIRCUIT
(b) TEST PROCEDURE NO 2 -- DTMF CIRCUIT
(c) TEST PROCEDURE NO 3 -- DP CIRCUIT
(d) TEST PROCEDURE NO 4 -- FEATURE GROUP D FOR EQUAL ACCESS

TEST PROCEDURE NO. 1

MF CIRCUIT

This procedure is used to access and test an MF circuit via the Model 966A Trunk Signaling Analyzer front panel jacks and keys. The 966A requires no switch for selection of pulsing type. An MF pulsing error is assumed to have been received.

Terminating Office



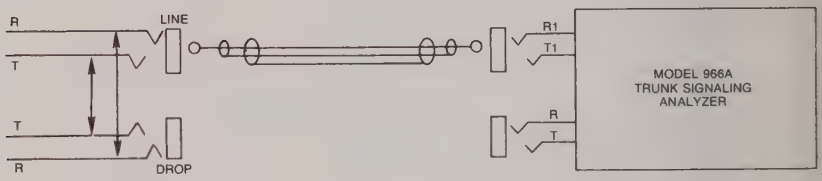
STEP	PROCEDURE
1	The Reset function has switched from AUTO to HOLD indicating an error has been detected by the 966A.
2	Depress and hold down the EXAMINE ERROR key.
3	The first digit with an error will flash on the MAIN DISPLAY for four seconds. Any succeeding errors will also flash for four seconds, one at a time. Mutilated digits will display an "E" while Pulse Limit Test failures will display the digit received.
4	As the display flashes the digit involved, the LED indicators at either end of the MAIN DISPLAY will indicate the cause of failure.
5	Depress the MANUAL key to erase the current display.
6	Depress the AUTO key to trap another error call. Try to establish a pattern of errors as an aid to determining the cause of the problem, i.e. always the same digit or the same location or the same missing frequencies.
7	The 966A can be used to determine the actual width and amplitude of pulses that are currently being trapped as errors. With Reset on HOLD and a call in the MAIN DISPLAY, operate the SET MS and SET DBM keys for new values, and then depress and hold the EXAMINE ERROR key again. This can be repeated as many times as necessary to determine the actual pulse parameters, i.e. width and amplitude. Note the value at which the error is gone.
8	If calls are not being completed on the first attempt or if calls are not being displayed on the MAIN DISPLAY and MF tones are audible on the speaker, the problem might be mutilated KP or ST codes. The 966A can be set up to trap such calls by enabling FEATURE 1 or FEATURE 2.
9	Trunks suspected of causing billing problems can be tested using FEATURE 3 or FEATURE 4.

TEST PROCEDURE NO. 2

DTMF CIRCUIT

This procedure is used to access and test a DTMF circuit via Model 966A Trunk Signaling Analyzer front panel jacks and keys. The 966A must be equipped with Option 03 for testing DTMF circuits. In normal operating mode, Touch-Tone* is disabled and must be activated. (See page 3, paragraph 1.12).

Terminating Office



STEP	PROCEDURE
1	Because DTMF signals originate from the customers telephone set, it is normally only necessary to set the DBM level of the Pulse Limit Test. Leave the MS at 30 and set the DBM at 3 dB below voice level (TLP).
2	With the Pulse Limit Test on TEST (red LED illuminated by TEST key) and the Reset on Auto (red LED illuminated by AUTO key), watch the calls in progress.
3	When an error occurs in a call, the Reset will switch to HOLD and the call digits will remain on the MAIN DISPLAY.
4	Depress and hold the EXAMINE ERROR key and the digit in error will flash on the MAIN DISPLAY. The LED indicators at the left of the MAIN DISPLAY will indicate what the error was.
5	To check more calls, depress the MANUAL key. This will extinguish the MAIN DISPLAY. Depressing the AUTO key will set up the 966A to trap the next error call.
6	Try to establish in a pattern of trouble, i.e. always the same digit or always in the same location, etc. to aid in finding the cause of difficulty.
7	The 966A can be used to determine the actual width and amplitude of pulses that are currently being trapped as errors. With Reset on HOLD and a call in the MAIN DISPLAY, operate the SET MS and SET DBM keys for new values, and then depress and hold the EXAMINE ERROR key again. This can be repeated as many times as necessary to determine the actual pulse parameters, i.e. width and amplitude. Note the value at which the error is gone.
8	If you have selected FEATURE 1 or FEATURE 2, the 966A Trunk Signaling Analyzer cannot detect DTMF signals.
9	The 966A uses a five-second time-out feature to detect end of signaling in DTMF operation. If it has not received a new digit in five seconds time, it assumes that no more are coming. If after five seconds a digit does appear, it creates a new record.

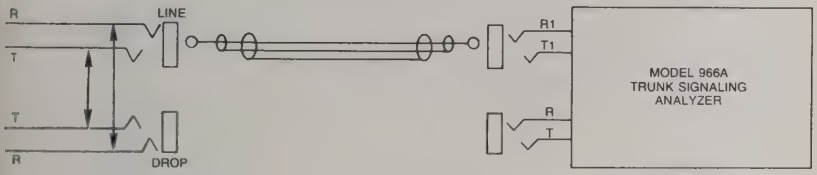
*Registered trademark of AT&T Co.

TEST PROCEDURE NO. 3

DP CIRCUIT

This procedure is used to access and test a DP (-48V) circuit via the 966A Trunk Signaling Analyzer front panel jacks and keys. No switch selection is required for pulsing type.

Terminating Office



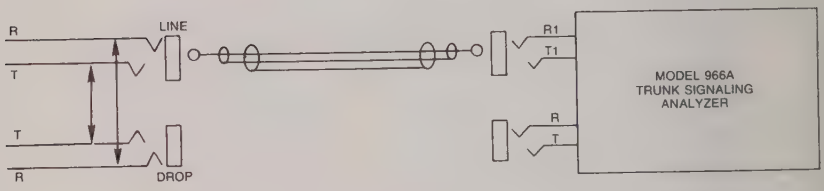
STEP	PROCEDURE
1	For DP operation, the 966A requires proper trunk supervision input. Trunk Type selection must be correct. Trunks using either LOOP or E&M signaling may be tested.
2	In the MONITOR mode, the 966A continues to store digits in one record (maximum 16) until an ON-HOOK condition is sensed. In the SIMULATE mode, the 966A counts digits and provides answering OFF-HOOK supervision and 1004 Hz call-completion tone upon call completion.
3	The Pulse Limit Test cannot be used on DP type circuits. DP pulsing in the range of 7-20 PPS is automatically accepted by the 966A Test Set.

TEST PROCEDURE NO. 4

FEATURE GROUP D FOR EQUAL ACCESS

This procedure is used for testing FEATURE GROUP D EQUAL ACCESS as provided by the operating telephone companies. The 966A must have the several FEATURES selected as needed by the types of calls expected.

Terminating Office



STEP	PROCEDURE
1	The trunk circuit should have been tested per TEST PROCEDURE 1 and found to be working properly for an MF trunk. This will allow the FEATURE GROUP D tests to test that protocol.
2	To monitor the calls on the FEATURE GROUP D service, it is necessary to set the number of records per call expected. This is done by selecting FUNCTION 6, 7 or 8 as needed. It is also necessary to select function 9, 10, or 11 to define winking after 1st, 2nd or 3rd record (usual settings are 6 and 9 or 7 and 10).
3	With the reset on AUTO and the TRUNK TYPE, DISPLAY, and MODE set as needed by the trunk, you can monitor calls in progress. If the RESET switches from AUTO to HOLD it means you have trapped an error. Refer to TEST PROCEDURE 1 for finding the MF error.
4	To simulate the Terminating office using the 966A it is necessary to disconnect the actual Terminating office to avoid duplicate signals. Using the appropriate jack field is the easiest way to accomplish this. Otherwise the circuit must be opened in some other way.

P. ACCEPTING DIGITS AND RECORD VIEWING

3.79 The 966A Trunk Signaling Analyzer is capable of receiving, storing and analyzing Dial Pulse (DP), TOUCH-TONE* (DTMF) and Multiple Frequency (MF) pulses.

3.80 When Dial Pulse (DP) is received in MONITOR, the number of DP digits received can vary. The 966A continues to store digits in a record until an ON-HOOK is detected, indicating the end of the call.

3.81 When DP is received in SIMULATE, the 966A detects the end of pulsing by counting digits.

3.82 DTMF can be received, analyzed and viewed on any RECORD, including OVERFLOW.

3.83 MF can be received, analyzed and viewed on any RECORD, including OVERFLOW. However, in REC 1 OVERFLOW, the 966A will switch from AUTO to HOLD as soon as the MF record is closed out (as with KP), and will not accept another record until reset. To reset, first press the MANUAL key, then press the AUTO key while in the Reset mode.

3.84 If OVERFLOW is used for viewing or analyzing MF in REC 2 or REC 3, the MF record can be closed. The 966A will not go into HOLD unless a mutilated digit or a digit which does not meet the preset Test Limits is received.

3.85 To view the first record only, press REC 1 while in Display mode. To view record 2, press REC 2 while in Display mode.

3.86 The entire record format can be viewed by selecting the BOTH key in Display. The MAIN DISPLAY will cycle every 4 seconds between REC 1 and REC 2, or between REC 1 REC 2 (Record 3) and OVERFLOW. Pressing the EXAMINE ERROR key will also sequence through the indivuidual records. The LED indicator associated with the record being displayed will illuminate. In OVERFLOW, the appropriate LED will be illuminated and the OVERFLOW LED will blink continuously.

3.87 The 966A Trunk Signaling Analyzer is able to store and view digits in REC 1 (Record 1), REC 2 (Record 2) and REC 1 REC 2 (Record 3), and each record's OVERFLOW. The total storage and viewing capacity is 96 digits.

3.88 The three keys in the Display group are used to select single- or two-stage display as required by the trunk being tested. REC 1 is selected for single-stage pulsing such as a simple interoffice calls. For records over 16 digits the OVERFLOW LED will illuminate and blink; up to 16 additional digits can be stored. These digits can be viewed by pressing the EXAMINE ERROR key. A blinking LED indicated REC 1 OVERFLOW is being displayed, and a steady LED indicates REC 1 is being displayed.

3.89 For two-stage pulsing, each stage is treated as a separate record. To record two-stage pulsing, select the BOTH key. The first record is stored in REC 1 and the second record is stored in REC 2.

3.90 Examples of record storage and viewing follow:

1. When ABC (Automatically Billed Call) feature is used (see feature selection, section G), three records are received, analyzed and displayed. The first record is stored in REC 1 and the second record is stored in REC 2. The LED indicators associated with each record will illuminate when it is displayed. The third record is stored in REC 2 OVERFLOW; when it is displayed, REC 2 LED will be illuminated, and the OVERFLOW 2 LED will blink continuously. To view the records, press EXAMINE ERROR or BOTH under Display. The records will be displayed every 4 seconds.

2. When FEATURE GROUP D EQUAL ACCESS is used in the three record pulsing format (see Feature selection, section G), the first record is stored in REC 1 and the second record is stored in REC 2. The associated LED indicators will illuminate when each record is displayed. The third record is stored in REC 3. When REC 3 is displayed, the LEDs associated with both REC 1 and REC 2 will be illuminated. To view the records, press EXAMINE ERROR or BOTH under Display. The records will be displayed every 4 seconds.

Q. IDDD (International Direct Distance Dialing) Signaling

3.91 The 966A, when equipped with FEATURE GROUP D EQUAL ACCESS, is able to simulate the carrier being accessed via an Access Tandem on an IDDD call. The sending protocol used by the Equal Access End Office for this type of call is as follows:

- Seize trunk and wait for an INITIAL wink from Access Tandem.
- When wink is received, outpulse KP--XXX-XXX-ST sequence.
- Wait for CCT (Carrier Connect) wink to start billing but do not outpulse.
- Wait for SECOND wink as repeated by the Access Tandem.
- Outpulse the second number KP-XX-XXXX-ST sequence
- Wait for acknowledge wink.

3.92 The following procedure is used to select the special Equal Access feature on the 966A for IDDD signaling.

1. Follow the power up procedure for the 966A as stated in the Verification test (section E).
2. Connect the 966A in the four-wire mode by connecting the front panel TR, T1R1, E&M jacks through the 310-cords to the trunk under test.
3. Press the "F" key. Its associated LED should blink continuously, indicating FEATURE select is ready.
4. All LEDs under Trunk Type, Function and Display should now be illuminated.
5. Select the appropriate key: 6, 7, or 8, for the number of records to be received (6 = 1 record, 7 = 2 records, 8 = 3 records). The associated LEDs will blink after selection.
6. Key 9, 10, or 11 must be selected, to match the wink back after required for each record (9 = wink back after record 1, 10 = wink back after record 2, and 11 = wink back after record 3). For example:

   If 2 records are needed to complete the IDDD call and a wink is required after each record, press keys, 7, 9 and 10. The 966A will also accept more than 1 wink between records when the For Access Tandem mode is selected.

   (a) After the appropriate keys are selected, press the "F" key to return the 966A to normal receive mode. The LEDs which were illuminated before entering Feature mode will again be illuminated.

   (b) While in Trunk Type, select either E&M Orginating for outgoing trunks or E&M Terminating for incoming trunks. While in Function, select SIMULATE WINK. In Display, select BOTH. Under Mode, select IDDD. Reset should be in the AUTO position. The 966A is now ready to receive the IDDD call.

   (c) After the IDDD call is completed, the 966A will transmit an answer back tone of 1004 Hz, +7 DB in E&M Originating or -16 DB in E&M Term-inating.

   (d) To reset the 966A, press the MANUAL key under Reset, and then press the AUTO key.

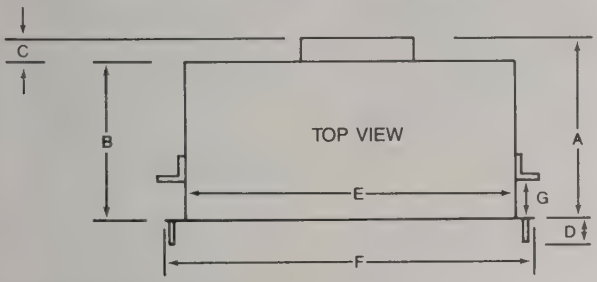
   (e) If Pulsing is stopped or drops off, the 966A must be reset to accept an-other call.

R. 966R Rack Mount Unit

3.93 The 966R Trunk Signaling Analyzer is provided ready to fit a standard 19-inch rack. Figure 13 illustrates the Model 966R dimensions.

3.94 To adjust the 966R to a 23-inch rack, remove the side bracket screws and handle screws. Remount the brackets to the chassis, using the screw holes previously used for the handles. Mount the handles in the screw holes previously used for chassis mounting. Figure 14 shows how to reverse the mounting brackets.

3.95 The mounting brackets for the 19-inch or 23-inch rack may be inset mounted up to four inches, in one-inch increments, along the side of the 966R case. Figure 15 shows the variable inset adjustments.



A = 11 3/8 " (28.9 cm)
B = 10 1/8 " (25.7 cm)
C = 1 1/4 " (3.2 cm) Terminal Block Cover
D = 1 3/ 16 " max. (4.0 cm) handles
E = Width, not including brackets = 17" (43.2 cm)
F: Width = 19" or 23" (48.3 or 58.4 cm)
Height = 3 1/2" (8.9 cm) standard rack height.
G: The mounting brackets for the 19 inch or 23 inch rack may be mounted up to four inches back along the side of the 966R, in 1-inch increments.

Figure 13. Model 966R Dimensions

Figure 14. Model 966R Mounting Bracket

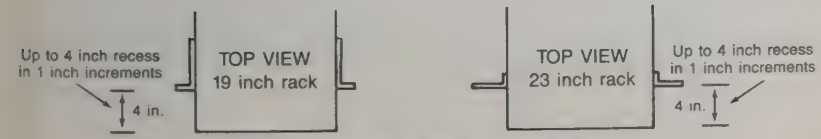


Figure 15. Model 966R Variable Inset Adjustments

3.96 The 966R Trunk Signaling Analyzer is available as a UL listed or CSA certified Rack mountable test set which will fit either a 19-inch or 23-inch rack space.

3.97 The 966R is powered by -48V DC through the rear panel barrier strip. It also provides access on the rear panel to the controls; i.e., TR, T1R1 and E&M.

3.98 DS1-PMC RECEPTION (Option 04) and DROP & INSERT (Option 05) are not presently available on the 966R. However, DTMF (Option 03) and Equal Access are available.

3.99 All Standard FEATURES provided by the 966A Trunk Signaling Analyzer are incorporated into the 966R Trunk Signaling Analyzer.

3.100 Operating procedures for the 966R are the same as those for the 966A. A few set-up procedures should be noted, however.

1. Power must be provided through the rear panel by -48V DC.

2. Front panel jacks are of the bantom type.

3. If the 966R is accessed in the four-wire mode through the rear panel barrier strip, a dummy bantom jack must be inserted in one of the Front Panel T1R1 jacks. This will mechanically switch the rear T1R1 from a High monitor impedance (300K nominal) to 600 ohm standard four-wire impedance.

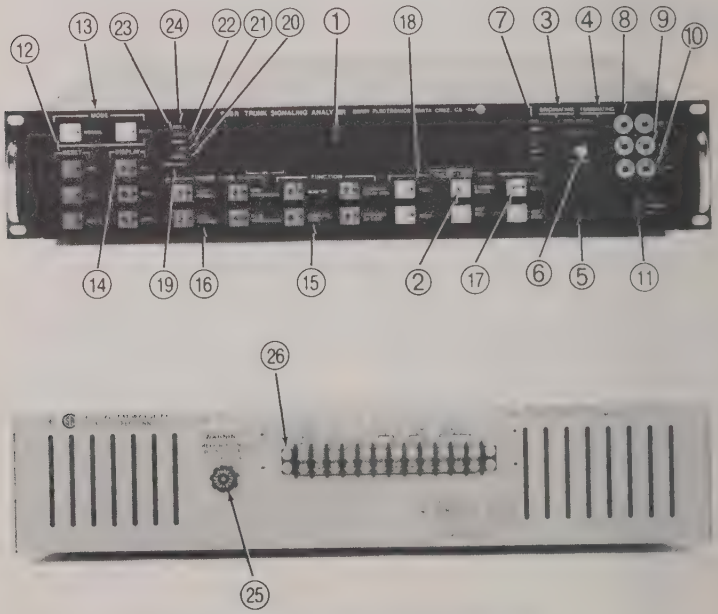


Figure 16. Model 966R Front and Back Panel

3.101 The 966R Trunk Signaling analyzer front panel layout, switches, jacks, controls and digital display, and back panel layout are shown in Figure 16. The circled callout numbers in the figure correspond with the circled callout numbers in the following text.

Physical Description 966R

① **MAIN DISPLAY** consists of 16 seven-segment red LED read outs. Up to 16 digits of either MF, DTMF (Option 04) or DP pulsing can be displayed at one time. Internal storage in the 966R permits recording of up to 96 digits of pulsing. For display purposes, the pulsing recorded is stored as two separate 16-digit records (REC 1 and REC 2). REC 1 is used to display single-stage outpulsing up to 16 digits. The extra digits are stored in OVERFLOW and the second stage in REC 2. Pulsing formats with more than two records, such as credit card calls, will store the third record in the OVERFLOW Record. The main display is also used to indicate the Pulse and level limits selected when using the Pulse Limit Test.

② **EXAMINE ERROR** key is a dual purpose key. During FEATURE GROUP D TESTING (when any FEATURE 6 through 11 has been selected) on (ABC) display, the key becomes an "X" key and can be used to examine record 1, 2, or 3, or overflow records as needed simply by operating the key. During "normal" trunk testing, the key is used for examining the Pulse Limit Test failures and to determine exactly the tones present in mutilated MF digits. When depressed and held, the EXAMINE ERROR key commands the 966R to flash the failing digit being examined and show the type of failure on the appropriate indicators. SHORT and/or LOW indicators are used for Pulse Limit Test failures and 1700, 1500, 1300, 1100, 900, and 700 indicators are used for mutilated MF digits. Each failed digit is examined and flashed for four seconds starting from the left of the MAIN DISPLAY and advancing one digit at a time to the right. This process starts and continues anytime EXAMINE ERROR key is depressed and held except during FEATURE GROUP D testing, as mentioned above.

③&④ Originating and Terminating **OFF-HOOK** and **ON-HOOK** red LED indicators are used to display the OFF-HOOK and ON-HOOK status of the Originating and Terminating offices of the trunk under test.

⑤ **LOUDSPEAKER** for monitoring signaling tones and circuit activity.

⑥ **VOLUME** control for setting audio output level.

⑦ **1700, 1500, 1300, 1100, 900, 700,** red LED indicators represent the different tones present in MF pulsing (1700 Hz, 1500 Hz, 1300Hz, 1100 Hz, 900 Hz, 700 Hz). These are used to indicate the tones present in mutilated MF digits when the EXAMINE ERROR key is depressed. These lamps only indicate the tones present for mutilated digits (digits with only one MF tone or more than two MF tones).

⑧ **TR** jacks are used to connect the tip and ring of the trunks under test to the 966R. These jacks are wired in parallel so that a "loop thru" type connection can be made. Jack spacing allows the use of double plugs if desired. For single-ended applications, either jack can be used.

⑨ **T1R1** jacks are used to connect the tip 1 and ring 1 of the trunk under test to the 966R. These jacks are wired in parallel for "loop thru" or single-ended use.

⑩ **E & M** jacks are used to connect the E&M leads of the trunk under test to the 966R. The E leads should be connected to the tip of the jack and the M lead to the ring. These jacks are wired in parallel.

⑪ **POWER** switch applies power to the 966R and initiates the microprocessor self-test. Following the self-test, the 966R will set itself up in the most commonly used mode of operation.

⑫ **Reset key** group is used to select the method of resetting the 966R. During a reset, the MAIN DISPLAY, both pulsing records, and the four LED indicators designated SHORT, LOW, ERROR and OVERFLOW are all cleared. For SIMULATE WINK, SIMULATE DELAY DIAL and SIMULATE BYLINK functions, answer supervision and the 1004 Hz call-completion

tone are also terminated when the 966R is reset. The three Reset keys are:

1. **AUTO**

   When selected, the 966R is automatically reset whenever a new MF, DTMF (Option 03) or DP record is received. The 966R can also be manually reset while in AUTO by using the MANUAL reset as described below.

   Certain pulsing errors cause the 966R to automatically jump from AUTO to HOLD. These include; OVERFLOW which occurs if more than 16 digits are received for one record; mutilated MF pulses (pulses which consist of one MF tone or more than two MF tones); or reception of an MF or DTMF (Option 03) pulse that is lower and/or shorter than the operator-set limits during a Pulse Limit Test. This feature of automatically jumping from AUTO to HOLD is particularly useful for trapping intermittent pulsing failures.

2. **HOLD**

   When selected, prevents the 966R from being automatically reset by the next record received as in AUTO. Useful for holding records to be analyzed. In HOLD, the 966R can only be reset by using the MANUAL reset described below.

3. **MANUAL**

   Momentary action key used to manually reset the 966R.

(13) Mode key group is used to select the 966R operating mode for use with either NORMAL or International Direct Distance Dialing (IDDD) trunks. The two Mode keys are:

1. **NORM**

   Used for all trunks except IDDD. In dual-stage outpulsing SIMULATE operation (CAMA, TSPS, etc.), second-stage outpulsing is initiated with a Terminating office OFF-HOOK. Also, all MF pulsing records must begin with KP (KP1) and end with ST, STP, ST2P, or ST3P. (Note: FEATURE 1 allows the reception of MF pulsing without beginning with KP (KP1) and ending with ST, STP, ST2P, or ST3P).

2. **IDDD**

   Used for International Direct Distance Dialing trunks either inside or outside the North American switched network. IDDD trunks inside the North American network connect domestic toll centers with International Switching Centers (ISCs). These trunks use two-stage MF pulsing with a momentary Terminating office OFF-HOOK (WINK) between stages instead of a continuous OFF-HOOK as employed by CAMA or TSPS. In the IDDD Mode, the 966A provides this same WINK in all two-stage SIMULATE functions. In this way, a 966A can simulate an ISC.

   IDDD trunks outside the North American network connect ISCs in North America with ISCs in other countries. These trunks use a slightly different version of MF pulsing known as CCITT Signaling System No. 5. In this system, MF pulsing records can begin with either KP1 (KP) or KP2 (ST2P) and must end with ST. In the IDDD Mode, the 966A follows the same conventions as CCITT Signaling System No. 5 for beginning and ending records.

(14) Display key group is used to select the 966R method of operation for either single- or multiple-stage outpulsing trunks. The keys select which RECORD is shown in the MAIN DISPLAY. The three Display keys are:

1. **REC 1**

   Used for single-stage outpulsing trunks. Pulses are stored in RECORD 1 and displayed as received. Also used to select RECORD 1 for MAIN DISPLAY.

   When REC 1 is selected and any

SIMULATE function chosen, the 966A simulates a Terminating office equipped to receive single-stage outpulsing. Answer supervision and 1004 Hz call-completion tone are sent after a single stage of pulsing for this condition.

2. REC 2

Used for dual-stage outpulsing trunks and to select RECORD 2 for the MAIN DISPLAY. The first stage of outpulsing is recorded in RECORD 1 and displayed as received. The second stage is recorded in RECORD 2 and displayed as received. At the completion of pulsing, RECORD 2 is shown on the MAIN DISPLAY. The outpulsing received in RECORD 1 can be reviewed by selecting REC 1. This is also used to display the third record of a three-part call.

3. BOTH

Used for three-stage outpulsing trunks and to command alternate display of RECORD 1 and RECORD 2 every 4 seconds. Reception of outpulsing is identical to REC 2.

(15) Function key group is used to select the Function of the 966A. The 966A can be used either as a pulsing and supervision monitor or it can be used to actually simulate the Terminating office. Three different types of simulation are provided: SIMULATE WINK, SIMULATE DELAY DIAL, and SIMULATE BYLINK (IMMEDIATE DIAL). In simulate functions, the test set acts as the Terminating office and provides battery and supervision just as the real Terminating office would. The four Function keys are:

1. MONITOR

When selected, allows the 966A to MONITOR trunks on a high-impedance bridging basis to insure no interference with normal trunk operation.

2. SIMULATE WINK

When selected, the 966A simulates a WINK start Terminating office, i.e. 200 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK of 150 ms (WINK). At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by the Trunk Type group keys.

3. SIMULATE DELAY DIAL

When selected, the 966A simulates a DELAY DIAL start Terminating office, i.e., within 80 ms after the Originating office seizes the trunk under test, the 966A provides a momentary Terminating office OFF-HOOK (Delay Dialing Signal) of 150 ms. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop or E&M signals are provided as selected by the Trunk Type group keys.

4. SIMULATE BYLINK

When selected, the 966A simulates a BYLINK (IMMEDIATE DIAL) Terminating office, i.e., Terminating office supervision remains ON-HOOK until outpulsing is completed. At the end of outpulsing, the test set sends a Terminating office OFF-HOOK to simulate answer supervision and a 1004 Hz call-completion tone. Appropriate Loop and E&M signals are provided as selected by the Trunk Type group keys.

(16) **Trunk Type** key group is used to select the type of trunk that is under test. This refers to the type of trunk supervision. These keys also serve as dual purpose keys to select special FEATURES. The special FEATURES are described in callout item 35. The four Trunk Type keys are:

1. LOOP NORMAL

Selected for trunks with Loop Normal

supervision. Loop Normal trunks have Battery on Ring for terminating office ON-HOOK and Battery on Tip for Terminating office OFF-HOOK.

2. LOOP REVERSE

Selected for trunks with Loop Reverse supervision. Loop Reverse trunks have Battery on Tip for Terminating office ON-HOOK and Battery on Ring for Terminating office OFF-HOOK.

3. E&M ORIGINATING

Selected for trunks with E&M supervision when the test set is in the Originating office. In the Originating office, the M lead is used for Originating office supervision and the E lead is used for Terminating office supervision.

4. E&M TERMINATING

Selected for trunks with E&M supervision when the test set is in the Terminating office. In the Terminating office, the M lead is used for Terminating office supervision and the E lead is used for Originating office supervision.

(17) The F key is used to select one of several special FEATURES. The F key is located in the Pulse Limit Test key group and initiates the FEATURE selection process. Individual FEATURES are selected by the numbered keys located in the Trunk Type, Function, and Display key groups. FEATURES 1 through 5 are associated with normal type trunk testing. They are selected by first activating the "F" key and then selecting 1 through 5. FEATURES 6 through 11 are associated with testing the FEATURE GROUP D SERVICE TRUNKS for "EQUAL ACCESS" and require pressing the "Simulated Wink" key before pressing the "F" key to activate them. The FEATURES are:

FEATURE 1: MISSING KP/ST DETECT

Detects and holds MF pulsing records which do not begin with KP and end with ST, STP, ST2P or ST3P. (Note: FEATURE 1 disables TOUCH-TONE* [DTMF Option 03] reception when selected).

FEATURE 2: NO KP REQUIRED

Accepts MF records without the normally required befinning KP. (Note: FEATURE 2 disables DTMF [Option 03] reception when selected).

FEATURE 3: MISSING ANSWER SUPERVISION DETECT

Detects and holds pulsing records when the Originating office remains OFF-HOOK for over two minutes without the Terminating office ever going OFF-HOOK.

FEATURE 4: DTMF RECEPTION

FEATURE 5: AUTOMATICALLY BILLED CALLS (ABC) DISPLAY

Records and displays the three-record pulsing format employed in Automatically Billed Calls (ABC). The First two records are MF for the Called and Calling number. The third record is DTMF (Option 03) for the credit card number.

FEATURE 6:

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting one record per call.

FEATURE 7:

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting two records per call.

FEATURE 8:

When testing the FEATURE GROUP D type protocol for EQUAL ACCESS, select this feature when expecting three records per call.

FEATURE 9:

When testing the FEATURE GROUP D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 1.

FEATURE 10:

When testing the FEATURE GROUP D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 2.

FEATURE 11:

When testing the FEATURE GROUP D EQUAL ACCESS, select this feature when protocol requires a WINK back after RECORD 3.

(18) **Pulse Limit Test** key group is located on the left side of the panel enclosed in a white outline. When activated, the Pulse Limit Test allows the operator to set predetermined limits for amplitude and width of MF and/or DTMF (Option 03) pulses and to compare these limits with the actual amplitude and width of each MF or DTMF (Option 03) pulse received. When pulses fail to meet these limits, the LOW and/or SHORT LED indicators located to the left of the MAIN DISPLAY are illuminated as appropriate. By using the EXAMINE ERROR key, the operator can tell which pulses failed which limits. Because the 966A actually measures and stores the amplitude and width of each MF and DTMF pulse received, it is possible to determine the values for individual pulses after the record has been captured. This is done by changing the amplitude and width limits and noting which pulses fail which limits. For example, if a particular MF digit causes the LOW indicator to illuminate when pulse amplitude limit is set to -6 dBm, but it remains dark at -8 dBm, then the amplitude of that pulse is in the range of -8 to -6 dBm. The five Pulse Limit Test keys are:

1. **TEST**

   Activates the Pulse Limit Test feature. Any MF or DTMF (Option 03) pulses which fail to meet the operator-set amplitude and width limits cause the LOW and/or SHORT LED indicators to illuminate as appropriate and the 966A to jump from AUTO to HOLD. This feature is useful for trapping intermittent pulsing failures.

2. **READ**

   Commands the MAIN DISPLAY to indicate the present MF and DTMF (Option 03) pulse limits used in the Pulse Limit Test. The pulse width limit is shown in milliseconds above the MS legend and the amplitude limit is shown in dBm above the DBM legend. Shown below is an example of using the READ command to view the Pulse Limit Test limit settings.

3. **OFF**

   Deactivates the Pulse Limit feature. Also used to initiate the FEATURE selection mode. See item 35.

4. **SET MS**

   Sets the pulse width limit. Each time the SET MS key is pressed, the MS display value increases by 5 milliseconds. The pulse width may be set over a range of 30 ms to 120 ms. Pulse width may be set in the TEST or READ condition. READ is used to set the desired test value limit. TEST can be used to determine the exact value of an MF or DTMF (Option 03) pulse by increasing the pulse width limit and noting when the SHORT indicator illuminates.

5. **SET DBM**

   Sets the pulse amplitude limit. Each time the SET DBM key is pressed, the DBM display value increases 2 dBm. The pulse amplitude may be set over a range of -24 dBm to +4 dBm. Pulse amplitude may be set in the TEST or READ condition. READ is used to set the desired test value limit. TEST can be used to determine the exact value of an MF or DTMF (Option 03) pulse by increasing the pulse amplitude limit and noting when the LOW indicator illuminates.

   NOTE: All keys, except SET MS, SET DBM, EXAMINE ERROR and

MANUAL have an associated red LED. The LEDs, when illuminated, indicate to the operator which keys have been selected.

(19) **OVERFLOW** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that more than 16 digits have been entered into a record. Also indicates the third record of a credit card call (CCC).

(20) **ERROR** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates an incorrect entry format or the incorrect use of controls.

(21) **LOW** red LED indicator located to the left of the MAIN DISPLAY. Only operates when the Pulse Test Limit is in the TEST condition. When illuminated, indicates that that an MF or DTMF (Option 03) pulse has been received that is lower than the operator-set Pulse Limit Test value.

(22) **REC 2** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that RECORD 3 is being displayed.

(23) **SHORT** red LED indicator located to the left of the Pulse Test Limit is in the TEST condition. Indicates that an MF or DTMF (Option 03) pulse has been received that is shorter thatthe operator-set Pulse Limit Test value. Also used to indicate that the digit being examined, by the EXAMINE ERROR key, is shorter that the Pulse Limit Test value.

(24) **REC 1** red LED indicator located to the left of the MAIN DISPLAY. When illuminated, indicates that RECORD 1 is being displayed or, if no display is present, indicates that RECORD 1 will be the next record displayed.

(25) **Fuse holder** located on the left side of the rear panel. Replace only with 0.5 amp, 250V fuse.

(26) **Barrier Strip** located on the center of the rear panel.

1. Provides access to the controls i.e., TR, T1R1 and E&M.

2. -46V DC input. This hookup is used to provide power to the 966R rack-mount model.

3. GND connection allows connecting of central office ground to the test set, Central office ground is supplied if -48V is connected to central office battery.

4. Remote (TRS) is not used on 966R.

S. RS-232 Printer Option Operating Instructions

3.102 If your 966A includes the RS-232 printer option, refer to the following instructions. Before powering up the 966A:

1) Make sure that:

- The printer is connected to the 966
- The printer is turned on and "on-line"
- There is sufficient paper in the printer to log all the events you expect to receive

2) The printer option for the 966A has four (4) possible baud rates for transmission. These are: 1200 (the default rate), 2400, 4800 and 9600. To activate a baud rate other than the default, the user must press certain keys while powering up. These keys are as follows:

- Press Auto Only = 2400 Baud
- Press Hold Only = 4800 Baud
- Press Auto and Hold = 9600 Baud

These keys must be pressed while the display is flashing all 8's [8888888888888] and held down while the display is showing the software number. Keep presssing down until the display shows the lazy "T" (it looks like this > ⊢). At this point the buttons may be released. If everything is hooked up correctly, your printer will generate a "set-up" report showing the default conditions.

3) The printer option can also generate a line feed to go with each carriage return sent to the printer. Some

printers want one, some don't. The default condition will not send a line feed. If your printer needs a line feed to work properly, you must press the "manual" key (in the reset row) during the initialization period (see 2 above).

4) If you need to change any of these settings after power up, you must turn the 966A off and go through the power up sequence again. Normally this will not be necessary.

5) If the printer becomes disconnected, the 966A should be powered down. The printer may then be reconnected and a full power up sequence is required.

After a Successful Power Up Sequence

3.103 You will know the power up sequence was successful because your printer will have printed a copy of the default settings on the front panel. The 966A printer option is capable of producing 2 different types of printout.

The first is the status report or "switch setting" printout. This report will reflect the conditions of the options selected on the front panel. In addition to telling trunk type, simulation selected, etc., it will print out the number of each of the feature options that you have turned on. If test limits are enabled, the millisecond and dBm settings of those limits will be reported to the printer. These status reports are available to the operator on demand.

To Get a Status Report on Demand

3.104 Press and hold the key in the "reset" row which is next to the LED that is lit up. This will be either the "AUTO" or "HOLD" key. While holding the first key, press and release the "MANUAL" key. After you have released the MANUAL key, a report will be sent to the printer.

The second type of report is the event report. This report reproduces all of the information available from the display of the 966A. These reports are automatic so long as a successful power up sequence is achieved and the printer continues to be connected to the 966A. When errors are detected in the signals being monitored, they are printed out in detail immediately after the digits are printed. Preceding each error is the position of the digit containing the error. Thus, if you look at the digit record and see [17145551212], and the printer says: position #3 30 MS, the digit referred to is the "7" not the "1". This is because the count always starts with the leftmost digit whether it is a number or character. Position one refers to the start tone "[" of a MF sequence and not to the "1" shown in this example. The number of milliseconds or amount of dBm printed in an error is the actual amount received, not the test limit and not the difference by which the digit failed. To determine the amount by which a particular digit failed, subtract the actual amount received from the test limits shown. Need a fresh copy of the test limits? Just call up a status report (see above).

4. MAINTENANCE

A. General

4.01 The Model 966A Trunk Signaling Analyzer uses microprocessor control for all its functions. No field calibration is required.

4.02 Field repairs for the 966A are not recommended. For technical assistance, contact the Repair Department at BERRY ELECTRONICS, Inc., Test Equipment Division, at (408) 429-1857.

B. Service Information

4.03 Complete warranty information is contained in the purchase order agreement under Terms and Conditions of Sale. Summarized briefly, the BERRY ELECTRONICS warranty extends for a period of one year to the original purchaser of a BERRY ELECTRONICS test instrument.

4.04 It is recommended that BERRY ELECTRONICS' Repair Department be contacted for assistance if , for any reason, a BERRY ELECTRONICS product fails to perform as expected. This step eliminates the needless delay entailed when a product is returned unnecessarily. Contact the Repair Department at:

BERRY ELECTRONICS, INC.
719 Swift Street, B-12
Santa Cruz, CA 95060
Attn: Repairs

C. Warranty Information

4.05 All BERRY ELECTRONICS, Inc. products are warranteed against defects in materials and workmanship for one year from the date of shipment. Any BERRY ELECTRONICS, Inc. products found to be defective during the warranty period will be repaired and recalibrated or replaced by BERRY ELECTRONICS, Inc. at no charge, only if returned to BERRY ELECTRONICS, Inc. for repair. Products whic have been damaged by customer misuse c repair other than by BERRY ELECTRONICS, Inc factory technicians will not be covered under thi warranty. BERRY ELECTONICS, Inc. is not liabl for any consequential damages. No othe warranty is expressed or implied.

D. Repairs

4.06 Any BERRY ELECTRONICS, Inc. produc found to be defective should be returned t BERRY ELECTRONICS, Inc. for repair. BERR ELECTRONICS, Inc. will repair, recalibrate an return your instrument. BERRY ELECTRONICS Inc. products covered under terms of the abov specified warranty, will be repaired or replaced a BERRY ELECTRONICS, Inc. expense. All othe repairs will be at the customer's expense Charges are based on time and materials.

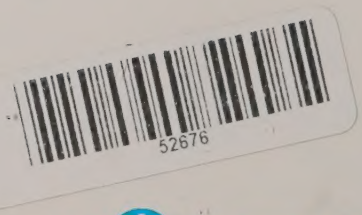
E. Returned Material

4.07 Whenever possible, BERRY ELECTRON ICS, Inc. products, being returned for repai should be shipped in the original shipping carton Enclose a detailed description of the problen encountered to aid in the repair of your instru ment. All instruments must be shipped to th following address:

BERRY ELECTRONICS, INC.
719 Swift Street, B-12
Santa Cruz, CA 95060
Attn: Repairs

CABLE SPINNING EQUIPMENT
Repair Center
100 West Central
New London, MN 56273

4.08 Equipment (in or out of warranty), whe shipped by air freight, will be repaired within 7 hours and reshipped air freight. Equipmer received by surface freight will be repaired with 10 working days.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